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The Straight Line Engine Company's Traversing Machine.

Some four or five years ago the writer,* in arguing the question of the loss of time and power in the use of large planing machines, suggested the possibility of using to advantage a vertical spindle in the place of the ordinary planer tool, and doing the work with two or more tools traveling in a circular path, rather than with the single tool with a reciprocating table. The Straight Line Engine Co., having work upon which a machine of this character would be as likely to succeed as on any other, the machine shown herewith has been built, and found so useful in many ways that it is believed a description will be of interest to your readers. Whether as a substitute for the planing machine pure and simple, this machine is a success, is not fully demonstrated, but the many jobs that it is capable of turning out, that cannot be done on the planing machine at all, render it more than probable that something of this kind will be developed that will be useful in many machine shops.

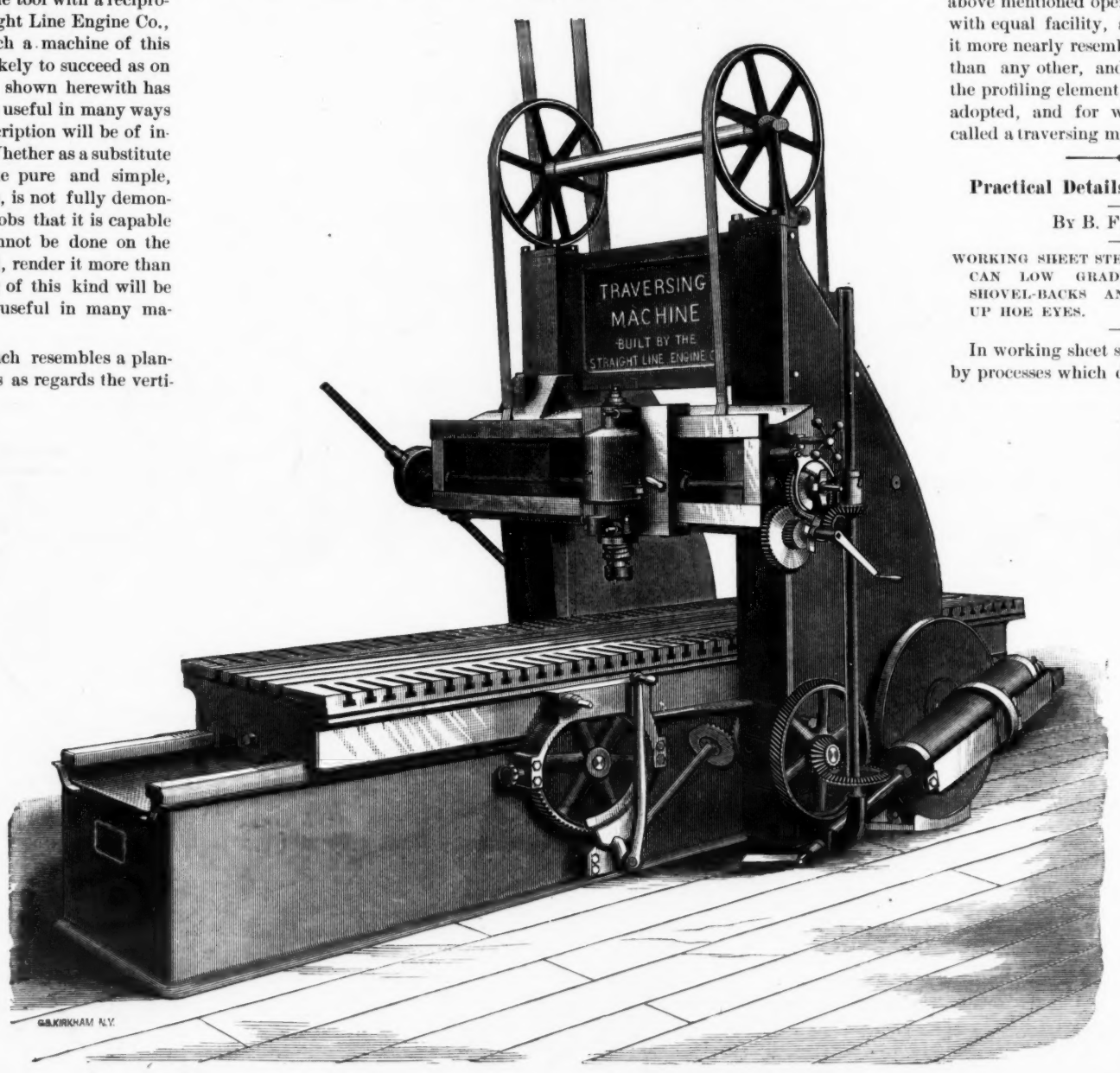
The machine very much resembles a planing machine, but differs as regards the vertical spindle; in the fact that the platen or table is fed back and forth at adjustable speeds, by power or rapidly by hand; and in the fact that the crosshead is fed up and down by power or rapidly by hand.

As regards details of construction, the machine differs from the ordinary planing machine in every particular. The bed is a complete box, having solid top and bottom, as well as sides, which has been proven by experiment to be 50 per cent. stiffer in a vertical direction, twenty times stiffer sideways, and thirteen times more rigid against torsional strains than the ordinary side plate and cross-girt system.

The table, 3′ × 12′, is also of the hollow box construction—8″ deep—full width between the housings, and carried on flat ways 3½″ wide. The housings are hollow boxes, as is the counter-weighted crosshead, the balance weights running in the housings. To resist the side strain of the cutting action, which is more severe than in a planing machine, the cross-beam between the housings or posts at the top is very wide, and the crosshead itself has a T slide cast with it, which serves as a vertical guide, and this, in connection with the vertical power feed, makes the machine an efficient boring machine, and a handy substitute for a radial drilling machine, having a capacity for this work of drilling a $\frac{3}{16}$″ hole up to boring one from 12″ to 16″ diameter, and anywhere in a structure 3′ wide, 12′ long, and any depth that can be placed under the boring tool or drill.

A fair idea can be formed of the arrangement of the mechanism from the cut. On the rear of the machine a belt from a cone overhead drives a cone shaft at the base of the machine. This shaft extends through and carries a leather-faced disk, and by shifting this belt (which is done by the enclosing box shown) nearer to or further from the center of the disk, the drum is caused to revolve slow or fast, as required, or by shifting the belt to the opposite side of the disk, the drum is rotated at varying speeds in the opposite direction.

In addition to the usual appliances to machines of this character, this machine is supplied with graduated scales not shown in shown in the engraving. Bevel gearing and a telescopic shaft convey motion to a splined shaft seen in the crosshead, and this, through the agency of either worm or spur gearing, gives motion to the vertical spindle at eight different speeds, varying from one to twenty-six, or from 5 to 130 per minute.



STRAIGHT LINE ENGINE COMPANY'S TRAVERSING MACHINE.

The leather-faced disk before mentioned (as seen at the lower right hand side of the cut) gives motion to all the various feeds, through the agency of a novel device. The iron drum running across the face of the disk is set about ¼″ away from it, and an endless leather belt, surrounding the drum loosely, is pinched between the drum and disk, so that as the disk rotates the friction between the three—that is, the disk, belt and the drum—causes the latter to rotate also, cut, for moving the work or cutter any given distance; this applies to the table, cross-feed or vertical adjustment of cutter. Each slide is provided with a locking device, so that when the bed or slides are brought to the required point they can be permanently locked in position.

A taper socket in the spindle, with bushes or collets and mandrels, adapts the machine to the use of all drills, reamers and milling cutters, and a quick pitch thread on the outside of spindle fits it for the use of large traversing cutters and boring tools.

Among the classes of work this machine is specially suited for is that of facing steam chests and valve faces, and at the same setting dressing out the ports and drilling the stud bolt holes. With the three center system used by this company for holding work, such jobs as facing both sides and boring both holes in connecting rods is done accurately and quickly. While all kinds, or nearly all kinds of planing, milling, boring and drilling are done, there is no change required in the machine—neither attachments nor fixtures, but simply a change of tools.

From the fact that either of the four above mentioned operations can be performed with equal facility, and from the fact that it more nearly resembles a profiling machine than any other, and yet does not possess the profiling element, a new name has been adopted, and for want of a better one it is called a traversing machine.

* The description of this machine was kindly furnished us by Prof. John E. Sweet.

Practical Details of Blacksmithing.

By B. F. Spalding.

WORKING SHEET STEEL—QUALITY OF AMERICAN LOW GRADE STEEL—CULTIVATOR SHOVEL-BACKS AND SLEEVES—STAMPING UP HOE EYES.

In working sheet steel into irregular shapes by processes which draw up the material, in a manner somewhat resembling that employed in drawing up cartridge cases from disks of copper, or in the stamping of tin ware, it is necessary that the stock used should be fairly tough. The property of ductility, which is requisite to the success of wire-drawing operations—that quality which permits stretching or extension by pulling—is perhaps the peculiar property which should be possessed by the material intended for these purposes; and yet the material which could be wire-drawn, cannot always be case-drawn, as iron which is easily split may be wire-drawn, because the tendency of the operation of pulling it through a hole is to keep it together, and make it closer, while the tendency of the operation of pushing a plate of metal into a hole, with a mandrel or "former," is to open the grain around the end of the "former." It must, therefore, be homogeneous, and hence capable of yielding equally to strains in all directions, without tearing apart. It is a gratification to be able to remark that there is very little trouble in this respect, even with the cheap grades of American steel. Out of some two hundred thousand of the shovel-backs, shown in Fig. 1, page 2, which have been brought under my observation, I cannot remember of seeing more than a dozen that had failed on account of seams. This is a better record than was made by some less than 5,000 pieces of 1¼″ x ¼″, which had a simple bending operation performed upon them.

They were bent on a line with their length, the angle being 120°, and the inside corner a circle of $\frac{1}{4}''$. The outside corner in these showed openings in 10 per cent. The stock for the shovel-backs was $2\frac{1}{2}'' \times \frac{5}{16}''$ cut-off $6\frac{1}{2}''$ long, round on both ends, with a horseshoe die, used in the punch press.

In one lot of three thousand, which was made on trial, to determine what steel would be best for the purpose, the temper was so high, and the stock so brittle, that about 15 per cent. were lost at the start, by nicking and breaking in the operation of cutting off. They acted about as thin stove plate would under like circumstances. From the punch press they were taken to the drop, and went through the operation of striking up without loss. The next thing to do to them was to punch the square cornered hole $\frac{7}{8}'' \times \frac{1}{2}''$, and the attempt to do this was very unsuccessful, for every one broke that was tried. A scheme was then attempted to be worked on them by first punching a half-inch round hole, as a starter, but an immediate loss of 75 per cent. and a prospective loss of the balance, in enlarging the hole to the full size, led to the abandonment of the project, until the pieces were annealed. They were heated in a reverberatory furnace, and put into ashes Saturday forenoon, and were barely comfortable to handle the next Monday morning, which should have given good softening results. They were then punched with a $\frac{7}{16}''$ punch and $\frac{1}{2}''$ die. The annealing had been so far beneficial that there was only a loss of about 25 per cent., and the enlarging and squaring of the big hole and punching the two small holes in the ends took off about 25 per cent. of the remainder, making the total loss about one-half of the stock. That experience decided once and for all that steel of that quality, of so high temper, could not be profitably worked for that purpose; and the steel afterwards ordered and received never gave any trouble, the loss in punching not exceeding $\frac{1}{10}$ of one per cent., although the square hole was punched at the first intention, without making a starting hole to relieve the strain. A pair of cast-iron dies with but little dressing would last to do about 10,000. If they were run too long, the ends of the inside die would become rounded, and the pieces would get hump-backed. This was to be avoided because it gave the shovel so much leverage on the bolts, which fastened it to the sleeves, Fig. 2, as to pull off the heads. It is evident that increasing the distance from the bolt-head to the point where the back rests on the sleeve, increases the short arm, and decreases the long arm of the leverage on the bolt. For this reason, some backs were made as shown in Fig. 1, the cup-shaped depression at *A* being drawn down by one blow at a first operation, and this serving as a guide to strike up, and finish shaping the pieces on another die. This operation was harder on the stock than drawing the first mould of a cartridge case, for the metal around the outside, beyond the depression, made a resistance which the case does not have to draw against. This resistance proved too great for the tenacity of the material, and the plan was abandoned.

This plan is adopted, however, I understand, in making the eyes, or handle sockets, for some kinds of hoes. In this the conditions are more favorable to success, in that the cup is considerably larger in proportion to its depth, and there is greater diffusion of the strain. The value of the product also allows the cupping to be done under the trip-hammer, a little at each blow, instead of all being done at one blow, thus giving the advantage of time to the yielding of the material, which is helpful, on the theory that its strength will hold out longer, to move with short steps, than with long jumps. In making the hoes, after the cup has been drawn, the bottom is punched out of it, a mandrel thrust through, and thus a nice socket is formed, which is of one piece with the hoe.

The making of the sleeve shown in Fig. 2 is not an illustration of drawing metal, but simply of bending it. This sleeve, to which the shovel is to be attached, is itself hinged to the plow, or cultivator beam. A wooden pin which will break, or a spring which will yield, at less resistance than will bend the beam, prevents an ordinary pressure against the shovel, from turning the hinge; but on striking against too great an obstruction, the pin breaks, or the spring yields, and the general constitution of the plow suffers no detriment. The front hole is for the hinge pin; the upper hole for the springs, and three holes in the end give different settings for the break-pins. These are to adjust the angle at which the shovel enters the ground. It is bolted on through the hole in the other end, which is slotted to allow of its being raised and lowered, to conform to the position of the others on the same frame.

This sleeve was at one time made of malleable iron, as was also the shovel-back, while the beam was of wrought-iron. Then commenced the rivalry with the Deacon's one horse shay: the beams bent, they were replaced with steel; the shovel-backs broke, steel backs were made; the bolt-heads broke off, larger ones were substituted; then the sleeves began to break, and that is why it became necessary to make them of steel. The stock used was $5'' \times \frac{5}{16}''$. It came in bars, and was first cut up into proper lengths, care being taken to cut the ends square. The next operation was to punch out the wine glass shaped hole, shown in Fig. 3, gauging from the back end, and one side. The shape of the hole had been ascertained before the punch and die were made, by cutting out some pieces to shapes, of which copies were kept, and these pieces were bent by hand,

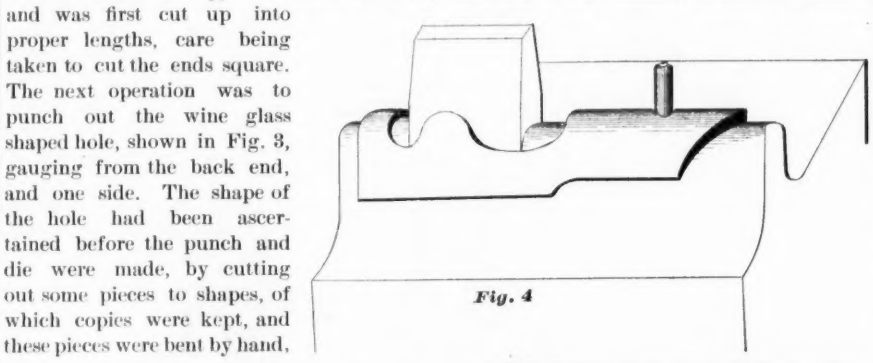


Fig. 4

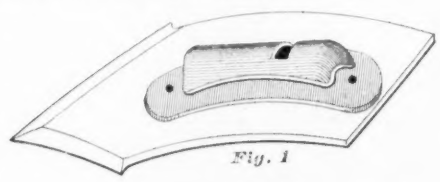


Fig. 1

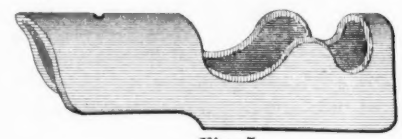


Fig. 5

Fig. 2

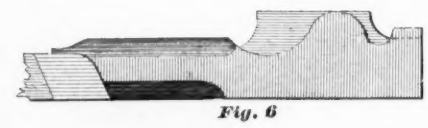


Fig. 6

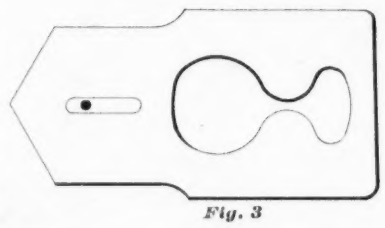


Fig. 3

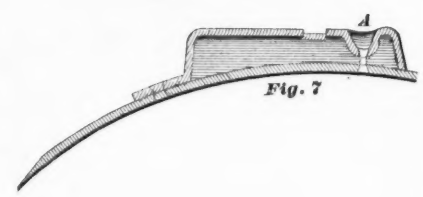


Fig. 7

PRACTICAL DETAILS OF BLACKSMITHING.

until the right form was obtained, and from this a solid steel punch and die were made. The hole was $3\frac{1}{2}'' \times 2''$. The die was $7'' \times 5'' \times 2''$. From this hole and the original gauging side, the $\frac{3}{8}''$ hole was punched, and from these two holes the outside was gauged and cut out, the original side and end being, of course, correct. If the pieces were not made uniform they made trouble. When they were cut to shape they were bent on a drop die, the face of which is represented in Fig. 4. The heated piece was gauged on this die by the two pins which are shown. One of them was flat, of the same thickness of the tongue, over which the whole piece was bent, but was tapering at the top to the width which would go between the lips of the punched hole. The other was simply a tapered round $\frac{3}{8}''$ pin, to enter the $\frac{3}{8}''$ hole. The upper die is not shown, but it will be understood that the mouth of it opened to correspond with the shape of the upper surface of the lower one. When it came down it struck on the outer edges of the steel, and, continuing to fall, bent it gradually to the size of the tongue. It was made two inches longer than the lower die on each end, for the purpose of having that amount at the ends cast in full, for if the groove had not been filled up, and had extended the whole length of the die, it would have caused the die to split. The filling in of the ends made the die strong enough to stand the strain of the blow. After this operation of bending, which left them in the shape shown in Fig. 5, and which, it will be noticed, did not bend the lips, but threw them out straight, they were reheated and put in another die on the mandrel seen in Fig. 6, which shows it with the sleeve remaining on, after being dropped. It was found necessary to make the projections, which are shown on the sides of the mandrel, for the front edges of the sides of the sleeves to rest on; for when they were dropped without this support, the stock was driven out of the top, down into the sides, leaving the top lacking in width. The hollowing out of the top on the front end to a circle of $1\frac{1}{8}''$ diameter was done by the upper die, as was also the squaring of the top at the back end.

The mandrel is shown broken off. It was long enough to hold in the hand. The lower die was simply a channel cut out in the block to the width of the sleeve, with two ledges left in it for the lower part of the front sides to rest on. This channel was not cut from end to end, but the block extended beyond it for 3″. It was open at the front end for the insertion of the mandrel, but had a reinforcement 2″ long cast in front, which only came up to the bottom of the channel, thus breaking the continuity of its lower corners. After the sleeves were struck edgewise in the channel, they were removed to another part of the die, and struck on the side. This finished the drop work. They were taken to the punch, where, resting on a convex die of $1\frac{9}{16}''$ circle, the long slot was punched by a punch long enough for the sides to rest against before the punch descended. This guided it sidewise, and it was gauged endwise from the front end. The other holes were drilled.

The latest addition to the list of high explosives is called carbo-dynamite. It is composed of ninety parts of nitro-glycerine absorbed by ten parts of a variety of carbon. Our London contemporary, *Iron*, gives an account of some experiments with it, which seem to show that it possesses several important advantages over ordinary dynamite, among others considerably greater power, and the generation of much less noxious vapor when exploded in confined places. It is claimed also to be entirely unaffected by water.

A Washington dispatch says: Supervising Inspector Lubbock, of San Francisco, having reported to the Treasury Department that petroleum is not safe fuel for large boilers, has been instructed by Secretary Fairchild to withdraw all permits heretofore given for its use, except in the case of small steam launches.

Modern Locomotive Construction.

BY J. G. A. MEYER.

SIXTY-FIFTH PAPER.

Counterbalance, continued.

In our last paper we have called attention to the fact that when the available room through which the counterbalance has to pass is not sufficient to permit us to use a counterbalance wholly made of cast-iron, we must adopt a lead counterbalance, for instance, such as is shown in Fig. 394. This figure represents a wheel center 33 inches diameter, and is designed for a narrow gauge (3 feet, or 3 feet 6 inches gauge) locomotive. Fig. 395 represents a section of the counterbalance through the line *a y* (Fig. 394), and, as will be seen, the counterbalance is cast hollow, so that it may be filled with lead. We use lead, because it is considerably heavier than cast-iron, and consequently we can obtain a counterbalance which will need less room than a cast-iron counterbalance of the same weight. We are compelled to seek a counterbalance of small dimensions, and yet a heavy one, because, on account of the small diameter of the wheel, the length of the arc $x\ x_2\ x_3$ (which is the length of the counterbalance), and also the depth *a y* are limited. The available space through which the counterbalance has to move will also limit the thickness $d_2\ e_2$ in Fig. 395. Another fact we must not lose sight of, is that, occasionally, in small wheels, the distance between the center of gravity *G* of the counterbalance and the center of the axle will be less than the length of the crank; consequently in cases of this kind the weight of the counterbalance will be greater than that applied to the crank-pin; such circumstances do not occur in large wheels. Under these conditions we must use lead in the counterbalance, so as to obtain satisfactory results. Small wheels leave us but very little choice in the length $x\ x_2\ x_3$ of the counterbalance, which frequently must be extended around the wheel as far as we can possibly do with advantage. The choice of the width *a y* is also limited; all we can do is to make it as wide as we can, leaving only sufficient room between the counterbalance and the hub, that is between *a* and *p*, for oiling the axle journals when the counterbalance stands above the center *j*.

The thickness of this class of counterbalances can be determined by the following method, which, in order to save labor, and promote simplicity, will give only approximate results, but close enough for practical purposes.

Example 79.—The length of the crank is nine inches; total weight applied to the crank-pin, which is to be counterbalanced, is 300 pounds; it is required to find the thickness of the counterbalance.

Make a drawing of the wheel center as shown in Fig. 394. Lay in the counterbalance, and let it extend from the center *l m* of the arm *A* to the center *o n* of the arm *B*. This length of the counterbalance is arbitrary; an experienced designer will know that, under the conditions, it must be made as long as possible; and anything beyond the lines *l m* and *o n* will add little, if any, appreciable effect to the counterbalance. Let us also decide to make the width *a y* equal to six inches; this will leave about as little room between *a* and *p* as we get along with in oiling the axle journal. Let us now consider that our counterbalance is simply a cast-iron box whose cross-section is rectangular as represented by the lines $d_2 f_2, f_2 p_2, p_2 e_2$ and $d_2 e_2$ in Fig. 395; also let us consider that the cross-section of the lead is represented by the rectangle *d e f g h*. Now the depth $d_2\ f_2$ of the box is established, the thickness of the sides of this box is also established, which is to be $\frac{3}{4}$ of an inch. We may, therefore, find at once the weight of sides $d_2 f_2$ and $e_2 p_2$ in the following manner: Midway between the arcs *m a o* and *l y n* draw, from the center *j*, the arc $x\ x_2\ x_3$, multiply the length of this arc by the depth *a y*, by the thickness of the side and by the weight of a cubic inch of cast-iron; the product will be the weight required; thus:

Assume that by measurement we find the length of the arc $x\ x_2\ x_3$ to be equal to 29 inches, then $29'' \times 6'' \times \frac{3}{4}'' \times .26 = 33.93$ pounds, which is the weight of one side, and $33.93 \times 2 = 67.86$ pounds, which is the weight of both sides, $d_2\ f_2$, and $e_2\ p_2$.

Let us now assume that the counterbalance is divided into a number of slices, as indicated by the dotted lines $d_2\ f_2$, $d_4\ f_4$, etc., each slice 1 inch thick, the divisions or cutting planes being parallel to the face $l\ m\ a\ y\ o\ n$ of the counterbalance. Let us now find the weight of one of these slices. Each one of these slices is composed of two kinds of metal, viz., lead and cast-iron. Of course, lead predominates. The weight of lead is generally reckoned at 0.41 pound per cubic inch. Consequently the area bounded by the dotted lines $r\ s$, $t\ u$, and the arcs $s\ v\ t$, $r\ w\ u$ multiplied by .41, will give the number of pounds of lead in one slice. The area of this surface of lead is found by multiplying the length of the arc $x_4\ x_2\ x_5$ by width $v\ w$. The width $v\ w$ is, under the given conditions, equal to $4\frac{1}{2}$ inches; and assuming that by measurement we find the length of the arc $x_4\ x_2\ x_5$ equal to $27\frac{1}{2}$ inches, we have for the weight of lead in one slice, whose thickness is one inch, $27\frac{1}{2}'' \times 4\frac{1}{2}'' \times .41 = 50.7{,}375$ pounds, say $50\frac{3}{4}$ pounds.

To this weight must be added the weight of the cast-iron included by the arcs $m\ a\ o$ and $s\ v\ t$; also that between the arcs $r\ w\ u$ and $l\ y\ n$, all one inch in depth. Let us assume that we have found by calculation the weight of this amount of cast-iron to be equal to $10\frac{1}{4}$ pounds, then the total weight of one slice will be equal to

$$50\tfrac{3}{4} + 10\tfrac{1}{4} = 61 \text{ pounds.}$$

Cut a templet to conform to the outline $l\ m\ a\ o\ n\ y$ of the counterbalance, and find its center of gravity G by the method shown in Fig. 385; lay off this center of gravity on the drawing, and measure its distance from the center j of the axle; this distance, we will say, is equal to $8\frac{1}{2}$ inches.

The moment of the force due to the weight applied to the crank-pin is equal to the product of the length of the crank into the weight applied to the pin, hence we have

$$300 \times 9 = 2{,}700.$$

The moment of the force due to the weight of the counterbalance is also equal to 2,700, hence the total weight of counterbalance must be equal to

$$\frac{2{,}700}{8.5} = 317.64 + \text{ pounds.}$$

But we have already found that the weight of the two cast-iron sides $d_2\ f_2$, and $e_2\ p_2$ (Fig. 395), is equal to 67.86 pounds. Subtracting this weight from the total weight of the counterbalance we have

$$317.64 - 67.86 = 249.78 \text{ pounds.}$$

This weight of 249.78 pounds must now be made up by the weight of the slices, into which the counterbalance has been divided. Therefore, we must now find the number of slices required to make up the weight of 249.78 pounds. Since we have found that the weight of each slice is equal to 61 pounds, we have

$$\frac{249.78}{61} = 4.09, \text{ say 4 slices.}$$

And lastly, since each slice is 1 inch thick, the thickness of the lead from d to e must be 4 inches, and the total thickness from d to e of the counterbalance must be equal to $4 + 1\frac{1}{2} = 5\frac{1}{2}$ inches. In this case we have left out the weight of the arms and rim, which must necessarily be cut out of the wheel to insert the counterbalance, but this weight is generally made up by filling the opening $g\ h\ i\ k$ with lead. Figs. 396, 397 represent a 42 inch wheel center with lead counterbalance, designed in one of our prominent locomotive works. It is suitable for heavy freight engines with cylinders 20 inches diameter and up to 22 inches.

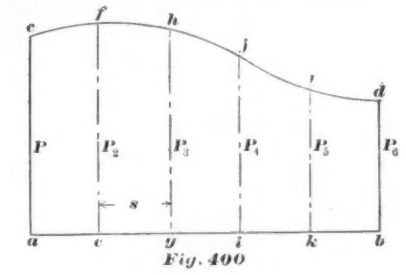


Fig. 400

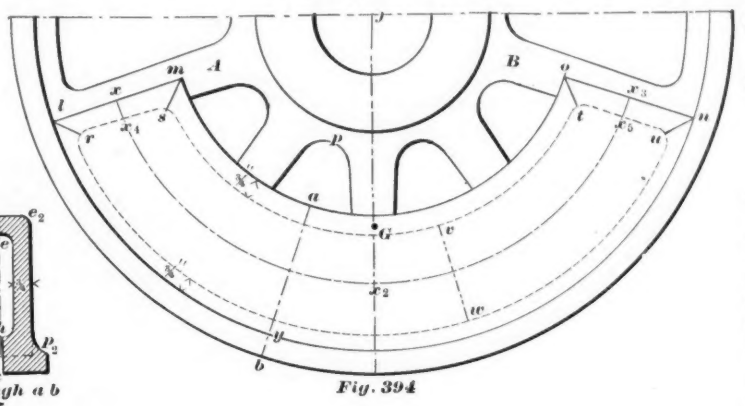
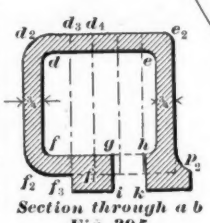


Fig. 394



Section through a b
Fig. 395

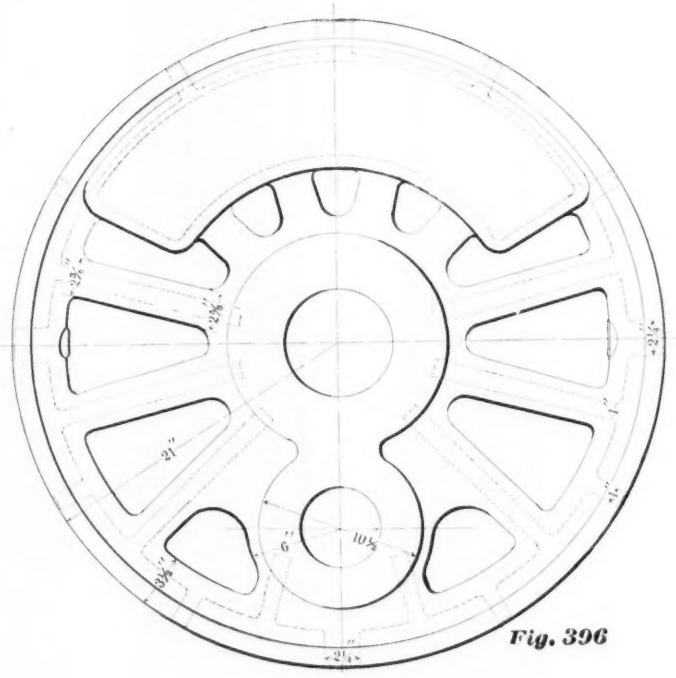


Fig. 396

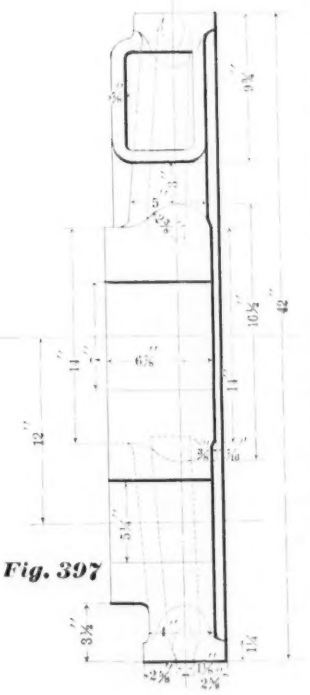


Fig. 397

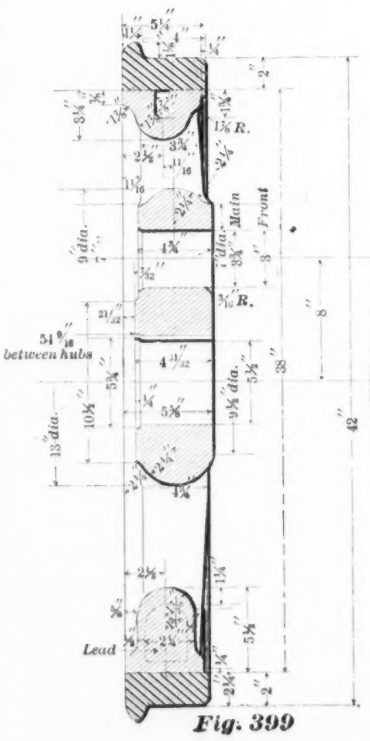


Fig. 399

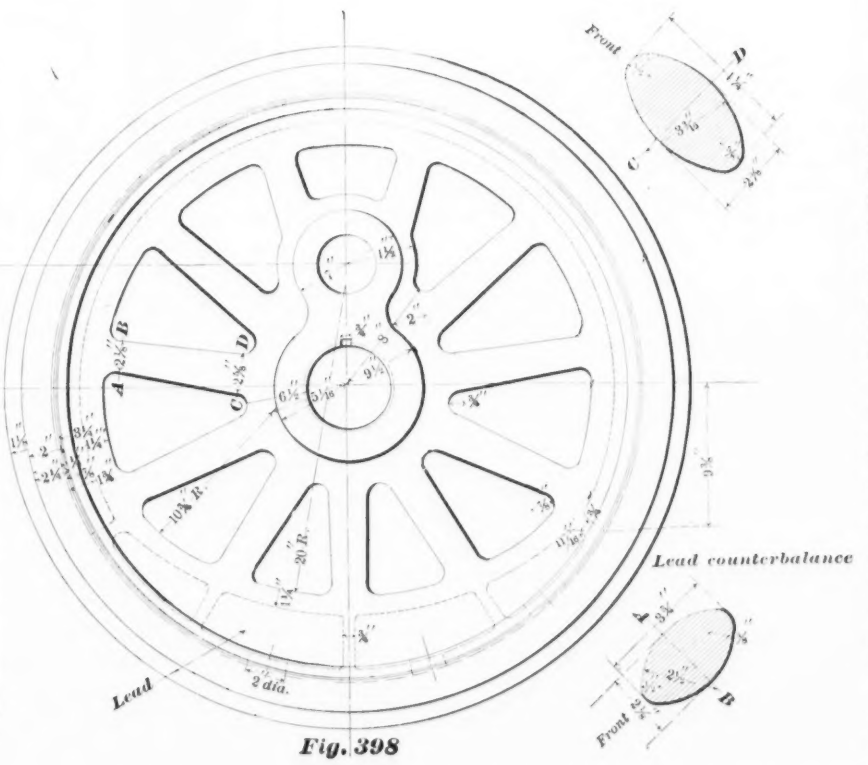


Fig. 398

Figs. 398,399 represent a driving wheel with lead counterbalance. It is used on elevated railroads. We believe that in this wheel the arms and rim could have been made lighter, and still be strong enough to do excellent service.

In locomotive construction we have sometimes to find the areas of plane surfaces or figures similar to that shown in Fig. 400.

The area of such a figure may be found in the following manner:

Divide the line $a\ b$ into any number of equal parts, say five, and through the points of division e, g, i, k, draw lines perpendicular to $a\ b$ terminating in the curve $c\ h\ d$. The lines $e\ f$, $g\ h$, etc., are called ordinates, and for the sake of simplicity we may also consider the lines $a\ c$ and $b\ d$ to be ordinates, although in reality they are bounding lines of the plane. Let P_1, P_2, P_3, P_4, P_5, P_6 represent the lengths of the ordinates, and S the distance between any two successive ordinates, that is to say, $S = e\ g$ or $g\ i$. The area of this figure may then be found by the following:

Rule 48.—To find the area between a given curved line and a straight line such as $c\ h\ d$ and $a\ b$ in Fig. 400. To one-half the lengths of the extreme outer ordinates add the length of all the intermediate ordinates and multiply the sum by the distance between any two successive ordinates; the product will be the area. Or putting this rule in the shape of a formula we have

$$(\tfrac{1}{2}\ P + P_2 + P_3 + P_4 + P_5 + \tfrac{1}{2}\ P_6) \times S = \text{area.}$$

Example 80.—Suppose we find the length of $a\ c$ equal to $2\frac{5}{8}$ inches, $e\ f = 3$, $g\ h = 2\frac{15}{16}$, $i\ j = 2\frac{9}{16}$, $k\ l = 2\frac{1}{16}$, $b\ d = 2$ and the distance S between any two successive ordinates equal to $1\frac{1}{4}$ inch; it is required to find the area.

$$\left(\frac{2\frac{7}{8}''}{2} + 3'' + 2\tfrac{15}{16}'' + 2\tfrac{9}{16}'' + 2\tfrac{1}{16}'' + \frac{2''}{2}\right) \times 1\tfrac{1}{4}''$$

$= 16\frac{1}{4}$ inches. The accuracy of the results depends on the number of ordinates; the greater the number, the greater the accuracy.

In our next paper we will give practical applications of this rule.

Remarkable Tire Record.

The Cumberland Valley Railroad received on April 15th, 1881, a locomotive built at the Rogers Locomotive and Machine Works, Paterson, N. J., and on April 20th, 1882, received another engine from the same works. These engines were numbered 32 and 35, respectively, and have done duty on passenger runs, making the round trip from Harrisburgh to Martinsburgh and return, a distance of 94 miles, or 188 miles daily. Engine 32 was brought in the shop to have her tire turned off, after making a run of 169,140 miles. She then made a run of 96,070 miles, and was brought into the shop for other repairs, when her tires were again turned. After this she was again brought in the shop for general overhauling, and has had her tires turned off after a run of 89,487 miles.

No. 35, however, has a remarkable record, her tires never having been turned off since coming on the road until this spring, when, having met with an accident, she had to be brought into the shop, and in the meantime had her tires turned off. The turning showed the tires to be less than one-sixteenth out of round in the most worn part. The mileage made by these tires was 328,969 miles. The following table shows the number of miles made each year:

1882.....	33,954 miles.
1883.....	57,594 "
1884.....	57,058 "
1885.....	57,930 "
1886.....	54,789 "
1887.....	55,654 "
1888.....	11,990 "
	328,969 "

These engines have 63 inch drivers, $16'' \times 22''$ cylinders, and with a concentrated weight on drivers of 46,550 pounds. The maximum grade they encounter going west is 45 feet per mile, and going east 40 feet per mile. The sharpest curvature is five degrees, but the general curvature does not exceed three degree curve. The average rate of speed on the road, of these engines, is 45 miles per hour.

These tires were made by the Midvale Steel Company, and apart from the excellent quality of the tires, due credit must be given to the Rogers Locomotive and Machine Works, for the excellent manner in which these engines were put together and counterbalanced. It is also gratifying to note the evident care bestowed on the engines in question by those who had them in charge. The condition of the road bed of course had much to do with the satisfactory working of the engines, and reflects credit on the chief engineer of the road.

Feed Water Purification and Disincrustants.

By W. H. Booth.

When lime salts are present in feed water for steam boilers they are deposited as evaporation takes place, and adhere more or less tenaciously to the plates of the boiler. As a rule, scale does not adhere thickly to surfaces exposed to the direct action of the fire, hence we find in heavily scaled boilers that the furnace plates will be, frequently, entirely free from scale. This is due to the frequent expansion and contraction of such portions of a boiler, as well as to the escape of steam bubbles from the plate surface, which prevents adhesion. The rapid movement of the water in the neighborhood of the furnaces also assists to prevent deposit of the many compositions designed to prevent incrustation. Some are positively dangerous. Against mere acidity, which causes corrosion, simply an alkali in proper quantity is all that is required.

Different compositions act very differently. Many are of a gelatinous nature, and these are supposed to act by formation of a slippery coating upon each particle of lime salt just as it is set free in the water. This coating isolates each particle and prevents aggregation, and also attachment. The result is simply a formation of slippery mud, which can be blown out occasionally, and best so when the boiler is most quiescent, as at the dinner hour and at night. Such compositions are more or less successful. In all compositions it is important that they be not introduced in large quantities at one time. The result of such a practice has more than once been partial collapse of furnace from overheated plates, consequent on the deposit upon the furnace plates of a lump of composition which has not dissolved or been washed away. Where possible it is best to mix the day's supply of composition with the feed water, into which it is run throughout the day in a small stream from a separate mixing tank. This cannot always be done, and in such cases the composition should be fed in as often as conveniently practicable, and through the ordinary feed supply.

For simple carbonate of lime the best antidote is probably common soda, which appears to act by removing from the water the excess of carbonic acid, which keeps the lime carbonate in solution, and so throwing down the lime, which can then be blown out, whilst the carbonate of soda formed remains in solution on account of its great solubility, and only escapes by blowing off.

For sulphate of lime the soda acts differently, the result being carbonate of lime, which is thrown down as a precipitate, and sulphate of soda, a very soluble salt, which remains in solution and escapes only by the blow-off.

The soda requires to be employed in two different forms for the two lime salts. In the first case the anhydrous variety must be employed, or soda made caustic. In the second case the carbonate must be employed. If both salts of lime be present in any water the caustic soda must be employed, for it first throws down the lime carbonate and becomes itself converted into the carbonate, and is then, of course, ready to act upon the sulphate of lime, which it turns into carbonate of lime, and itself becomes the soluble sulphate of soda, as before described.

Properly speaking, however, the interior of a steam boiler is not the place wherein to carry on a chemical process, and such operations as above described are best made in separate vessels, wherein, by the addition of the proper salt of soda, the lime salts may be precipitated and filtered out; the purified water then passing into the boiler. Such an arrangement could be readily fixed up in many places where a little spare room is to be had, and there can be no doubt would recoup itself in saving of fuel and expense in boiler cleaning. It is too little recognized that there is no absolute need for a boiler to be cleaned. If fed with clean water the interior of a boiler needs no cleaning, and we have seen boilers which have run for months without cleaning, and with very little blowing off, for which practice also there ought to be no occasion, for it is only because of dirty feed water that blowing off is required at all. Where water is acid, scale cannot attach itself, because of the constant washing of the plate surface. In such cases, to prevent vital and rapid destruction of the boiler a large quantity of alkali is required. The daily amount can be estimated by testing a gallon or a hundred pounds of the feed water by the addition of as much of the alkali as will prevent the reddening of a litmus test paper. Then so much soda must be added for each gallon or hundred pounds of water evaporated, and an approximate estimate of evaporation may be made by taking it at eightfold the weight of coal consumed. Thus if a boiler consumes 1,000 pounds of coal daily it will evaporate about 8,000 pounds of water, and if two ounces of soda are found to be necessary to neutralize the acidity of 100 pounds of water, we should find it necessary to inject daily 10 pounds of soda to prevent active corrosion of the plates of the boiler.

This would be an extreme case of acidity. In all cases of acidity it is well to make at least one, if not two daily tests, with litmus paper, of a sample of water drawn direct from the boiler. If the litmus reddens, the amount of alkali must be increased; but it is not wise to have the water strongly alkaline, both because of the waste of alkali and the destructive action, on many brasses, of alkaline water. Simple neutralization of the acidity is sufficient. It is probable that, in case of acid feed water, neutralization might be effected by passing the feed through broken limestone chips, which would not merely neutralize the acidity of the water, especially if this were due to the presence of sulphuric acid, but would also cause a slight sulphate of lime scale to form upon the plates, and so protect the boiler from corrosion.

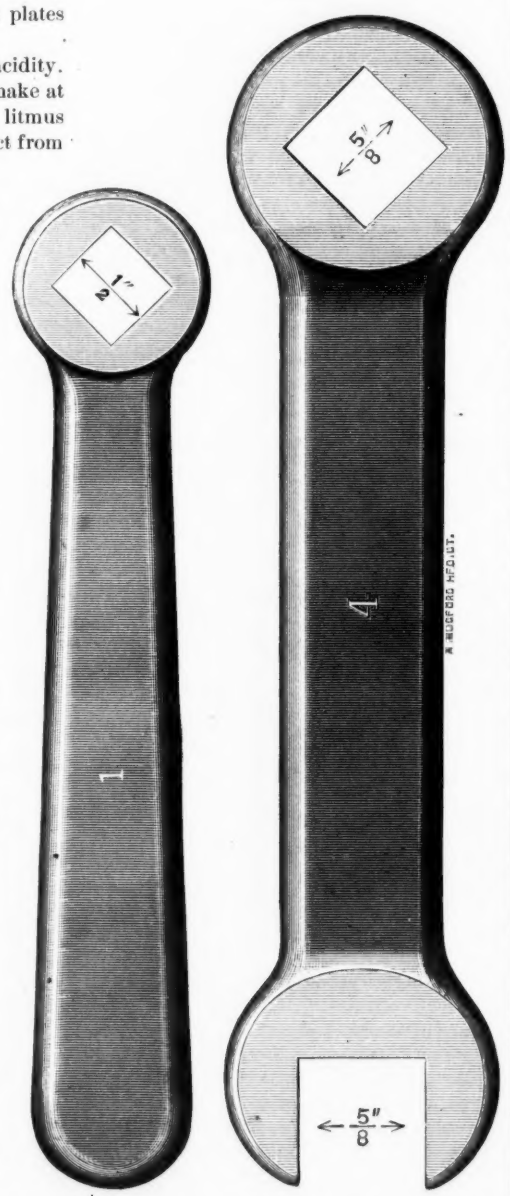
The writer once tried using lime for a case of acid feed supply with good results, succeeding in protecting some rapidly wasting furnace crowns by a thin hard scale, but was prevented from carrying on the test for a length of time sufficient to form definite opinions. When purification can be effected outside the boiler, carbonate of lime may best be neutralized by the further addition of plain lime in just sufficient quantity to absorb all the free carbonic acid in the water, when both the added lime and the previously contained carbonate are precipitated as carbonate. The process is best carried out with a large tank into which is run a solution of common lime. The length of the tank is such that the deposit takes place in it, and if properly managed the effluent water is almost pure, and, being drawn off from the upper surface of the tank, is filtered through bags of closely-woven material, which can be changed and cleared as occasion may demand. These filter bags remove the bulk of any further lime not deposited, and the material thus separated is the finest whitening. In a boiler fed with water thus treated the only dirt found at cleaning was a pure white deposit, non-adherent.

Many boiler compositions contain tannin in some form, either as an extract of tan bark, of chestnuts, or other material. Such compositions are usually made largely alkaline, but must be used with caution, as they are apt to form tannic acid, which will attack the plates of a boiler. I have known such compositions, however, to give good results. The use of mucilaginous compounds and others of kindred nature is not usually advisable; their action, as already stated, is more mechanical than chemical, and if used they should therefore be injected in small continuous quantities.

Soda with many waters causes the formation of, floury deposit, in which case the greatest care must be exercised to prevent the introduction of all grease. Floury deposit causes priming, and leads to destruction of slide valves, etc. Soda is objectionable on this account in many instances.

When kerosene is used as a disincrustant it would appear best to paint it thickly upon the scale in the empty and dry boiler, avoiding the use of a light, of course. So applied, it is stated as very efficacious in loosening old scale. Vegetable or animal grease must be strictly avoided.

The *Tribune* says: "One of the twenty-one 'amateur steel inspectors,' as the Navy Lieutenants are called, who are detailed to inspect and test the quality of the steel for the new cruisers, was asked the other day what he had to do at the steel works. He replied in all seriousness: 'Principally dodging the sparks.' People acquainted with the forging of steel will appreciate such a reply."



Drop-forged Wrenches.

The cuts on this page show some forms of wrenches recently added to the list made by the Billings & Spencer Co., Hartford, Conn. They are what are known as box wrenches, and are intended for the tool posts of lathes, or other places, especially where it is desirable to leave the wrench upon the head of the screw.

These wrenches are drop-forged of a tough open hearth steel, low in carbon, and will stand any reasonable strain put upon them. A full line of different sizes of the two styles is made, and they are broached out to standard sizes, finished and case-hardened.

Speed of Special Tools.

By W. D. Forbes.

The work done by the mechanical world can be broadly divided into the occasional and the constant. The first named class is required for special reasons, and, generally speaking, the cost is not of primary importance, while the second class is universally demanded, and the question of cost is all-important; for examples may be cited as extremes, a pumping engine for a mine, and a sewing machine. In the one, little or no (special) machinery is used, while the other employs only special tools and fixtures for its production.

Competition has caused thousands of dollars to be expended to perfect and increase the production of automatic tools, and the end is not yet. When the subject is studied two questions of great importance at once present themselves for answers, *i.e.*, which is better, increase the speed of a tool, and thus its output, or have a second machine to accomplish the desired end? Circumstances in many cases decide the question, leaving no alternative.

For instance: Where no room can be had for a second machine, or where the cost of tool is excessive. But which is, in general, the better engineering, high speeds in one machine, or leisurely movement in two? Let us look into this matter.

It is to be supposed that when the increase of speed is under consideration that the tool has been designed originally with proper cutting speed, remembering, of course, that commercial results are looked for, and not simply possible momentary action.

Such being the case, a gain in speed is limited to returns, shifting and feed motions.

We will suppose the article to be made is like Fig. 1, which is a pilaster head stud screw, and it is necessary that its head should be concentric with its stem and screw, thus necessitating a cut being taken to correct any eccentricity which might arise from the chuck jaws not running true, or the stock not being a true cylinder.

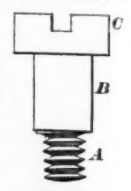


Fig. 1.

The motions to produce such a screw on a screw machine with self, or, as it is generally called, wire feed, are as follows:

	Movements.	Cuts.
Opening of chuck jaws	1	
Feed in of rod	2	
Closing of chuck jaws	3	
Roughing cut over *B* and *A* taken together	4	1
Return of turret	5	
Shift " "	6	
Cut to size *C*, or head	7	2
Return of turret	8	
Shift " "	9	
Finishing cut for *B* and *A*	10	3
Return of turret	11	
Shift " "	12	
Threading part *A*	13	4
Reverse of machine Return of turret	14	
Feed in of cut-off tool	15	
Return of " " "	16	
Shift of turret for stop	17	

Ordinarily but one speed is given to a screw machine, unless the diameters to be finished vary greatly; consequently in our example the speed which is admissible must be computed from the larger diameter on the head *C*.

It is evident, then, that the work done on the parts *B* and *A* is done at a disadvantage, and this is augmented by the great length of cut as compared with the cut on head; it would therefore appear that a change of speed is a possible advantage in a screw machine under our conditions, but such a change must be made automatically, and not by means of a shifting belt from one step of the driving cone to another, as this could hardly be made with sufficient speed.

If, therefore, it is decided to run with a second speed, it appears preferable to have two belts running constantly at different velocities, and by means of a friction pulley to shift from one to the other. Of course a screw machine so made would require a countershaft capable of several speeds, in order to adapt it to various jobs. Now we can gain by a change of speed, but at what disadvantage?

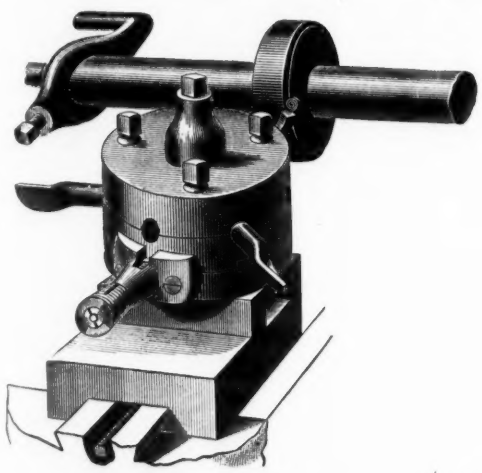
It must be conceded that a pair of friction pulleys are more complicated than a cone pulley, and to this must be added the further complication of the necessary shifting apparatus to employ them, all of which makes the first cost of the machine greater,

and its repairs, in the nature of things, will be greater; also the ability of the man in charge of the machine must be of a higher order, and, in return, he will require better pay; all of which is offset by the larger output from the increased speed.

If, as stated before, circumstances will not permit a second machine, shifting speeds in a screw machine are admissible, and can be made to pay. Although it is more scientific to run work at a proper speed, it is, generally speaking, more commercially correct to get work done at as small a cost as possible of wages and interest on tools, and a gain of output must be very considerable to invite radical changes such as shifting speeds on small screw machines. But there are some chances to increase the output of a tool without radical changes.

Of the seventeen motions noted before, five of them only perform work; the other twelve simply prepare the tools and stock for the cuts, and it is evident that the less time taken in preparation for the actual work, the greater will be the output. It will cost very little, and add not a single extra part to a tool, to have the preparatory motions performed with the greatest possible speed and with as little clearance as possible. It only necessitates a change of pulleys for the shifting devices to give greater speed, and a close adjustment in the general set of the machine. It will surprise many to see the additional output then obtained. But these preparatory motions must not be carried to excess, or the adjustments must not be too close, as, if so, too great an amount of bad work or stoppages will overshadow the advantages gained.

Generally speaking, it is safe to say that it will be better economy to have several machines of moderate speeds and of simple construction than one of complicated high speed, taking it year in and year out, but there is no doubt but that very brilliant results can be obtained for a short time, on a complicated tool, apparently showing large gains; but the practical world has for a long time been better satisfied with a certainty of output than with an intermittent one.



A Rotary Tool Post.

Something of a novelty in the way of a tool post is shown by the accompanying engraving, which, though called by the maker a rotary tool post, is really a turret arranged to go on to the tool post block, instead of the tail stock. Mounted in this way, the tools can be given all the motions, and used in the same way as ordinary tools, held in an ordinary tool post.

The lower plate has a tongue to fit the tool post block, and is secured in place by a square-headed bolt, which passes through to the top of the turret, where there is a nut by which it is tightened. This nut is covered by the sleeve nut shown on top, which, when tightened, prevents the turret from being turned.

The tools are made of ½" round steel, left rough, and forged into the desired shape. The turret is in two parts, which, when the tools are inserted, are held a short distance apart, so that when the three screws on top are tightened they draw the two parts of the turret together, binding the tools in place. There are six holes for tools, and the stop by which the turret is indexed is wedge-shaped, to take up wear, and is forced into place by a spiral spring.

It will readily be perceived that the usual methods pursued in doing lathe work, which consists of a number of small pieces alike, and having a number of operations upon each piece, can be changed by the use of this device, often with decided advantage. Instead of removing the piece from the lathe after each operation, and going through the whole lot before changing, or, instead of changing and setting a tool for each operation, the piece can be left in the lathe, and, by swinging the turret, the various tools needed to complete the job can be brought successively into proper position. For instance, in turning gear blanks three tools could be used, a diamond point, and right and left-hand side tools, and the blank finished without the necessity for taking out or resetting a tool.

Work held in the chuck may be bored and threaded in the same way, and there are many jobs which will suggest themselves, for which it might be used to advantage.

The stop, when pulled out, can be prevented from springing into place again by turning a thimble which is on the handle, and when this is done the tools can be held at any desired angle by tightening the sleeve nut on top of the turret.

The manufacturer is John Birkenhead, Mansfield, Mass.

Notes on the Expansion of Steam.

BY RICHARD H. BUEL.

FOURTH PAPER.

The power developed by a steam engine working under fixed conditions, is of three kinds:

1. The total horse-power.
2. The indicated horse-power.
3. The net or effective horse-power.

Knowing the effective area of piston in square inches (D), the piston speed in feet per minute (S), the mean total pressure (or the mean pressure during a stroke, above the vacuum line) in pounds per square inch (P), the mean indicated pressure (or the area of the indicator diagram in square inches, divided by the length of the diagram in inches), in pounds per square inch (I), and the mean effective pressure (or the mean indicated pressure less the friction pressure of the engine), in pounds per square inches (N), the power can be calculated by the following formulas:

Total horse-power

$$= \frac{D \times S \times P}{33{,}000}$$

The indicated horse-power

$$= \frac{D \times S \times I}{33{,}000}$$

The net or effective horse-power

$$= \frac{D \times S \times N}{33{,}000}$$

The following data represent a case in actual practice:

Effective area of piston = 250.9 square inches.

The mean total pressure=46.4 pounds per square inch.

The mean indicated pressure=29.3 pounds per square inch.

The mean net pressure=26.8 pounds per square inch.

Piston speed=548 feet per minute.

Hence,

The total horse-power

$$= \frac{250.9 \times 548 \times 46.4}{33{,}000} = 193.3$$

The indicated horse-power

$$= \frac{250.9 \times 548 \times 29.3}{33{,}000} = 122.1$$

The net horse-power

$$= \frac{250.9 \times 548 \times 26.8}{33{,}000} = 111.7$$

The total horse-power of an engine is used in theoretical calculation, as will be explained hereafter. The indicated horse-power is ordinarily employed in this country, to represent the performance of an engine. The net or effective horse-power, being the power available for useful work, and which can be measured by a friction brake on the fly-wheel, a transmitting dynamometer on the main shaft, or some apparatus for registering the tension of the main driving belt, is usually made the standard of comparison in European tests, and is the power which especially interests the owners of engines. Evidently, it would be poor economy to purchase an engine which was very economical in the consumption of steam, referred to indicated horse-power, if, by reason of excessive friction, the steam consumption, when referred to net horse-power, was excessive. The following table, representing the results of tests where the effective horse-power of the engines was measured with friction brakes, shows clearly that it would be advantageous for a steam user to purchase engine 2 or 4, rather than engine 1 or 3, although the latter engines are more economical than the former, when the measure of economy is gauged by the indicated horse-power.

ECONOMICAL PERFORMANCE OF NON-CONDENSING ENGINES, REFERRED TO INDICATED AND NET HORSE-POWER.

Numb'r of Engine.	Mean Pressure, Pounds Per Square Inch.			Pounds of Water Hourly.	
	Indicated.	Net.	Friction.	Per Indicated H. P.	Per Net H. P.
1	31.1	25.5	5.6	25.5	31.1
2	29.3	26.2	3.1	27.2	30.4
3	36.9	30.3	6.6	23.6	29.0
4	42.0	38.2	3.8	24.2	26.6

These figures are taken from tests of engines built by makers of high reputation, and all the results are fair.

An examination of a large number of experiments made with engines, where the net horse-power was measured either with a friction brake or a dynamometer, shows the following range of friction pressure in pound per square inch of piston area:

	Non-Condensing Engines.	Condensing Engines.
Friction pressure, unloaded engine.....	1.8— 2.2	2.4— 2.8
Friction pressure, loaded engine.....	2 —11	2.5—13.3

It is believed that the foregoing data justify the plan adopted in this discussion of basing the economical performance of an engine on the net, rather than the indicated, horse-power, and purchasers of steam engines, in drawing specifications, might well call for bids on the same basis.

To construct the theoretical diagram of a proposed engine, it is necessary—if the theoretical diagram is to have any practical value—to make certain suppositions, based upon the known performance of other engines; and if these suppositions are founded on good practice, the theory will be a true one, simply stating that like causes produce similar effects. In the present discussion, whenever any assumption is doubtful, an attempt is made to err on the safe side, so that the final results may be well within the practical limit.

An illustration of the manner in which a theoretical diagram can be drawn, closely approximating the actual indicator card, when sufficient data are at hand, will now be explained.

In Fig. 6, $A\ B\ C\ D\ E\ F$ represents an actual diagram taken from a condensing engine—$G\ H$ being the vacuum line, B the point of cut-off, and E the point of exhaust closure. The following data were obtained by measurement of the engine and diagram:

Clearance = 4½ per cent. of piston displacement.

Length of diagram $G\ H = 5.27$ inches.

Length of clearance space $H\ I = 5.27 \times .045 = .24$ inch.

Distance from commencement of stroke to point of cut-off $K\ H = 2.78$ inches.

Distance from commencement of return stroke to point of exhaust closure $G\ L = 4.26$ inches.

Mean absolute pressure, pounds per square inch, up to point of cut-off, clearance included (= mean altitude of figure $O\ N\ A\ B\ K\ I$) = 47.1.

Absolute pressure, pounds per square inch, at point of cut-off $K\ B = 45.3$.

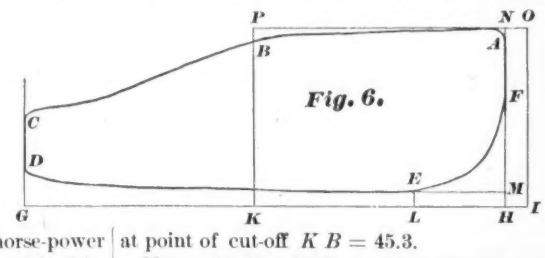


Fig. 6.

Mean absolute back pressure, pounds per square inch (= mean altitude of figure $D\ M\ H\ G$) = 6.8.

Absolute pressure, pounds per square inch, at point of exhaust closure $L\ E = 4.3$.

In Fig. 7, these values are laid off to some convenient scale, $K\ P = 47.1$; $K\ B = 45.3$; $G\ D = 6.8$; $L\ i = 4.3$; and the absolute pressures in pounds per square inch, for different points of the expansion and compression curves, are calculated as follows:

EXPANSION CURVE.

Pressure at 3½ inches,

$$a\ b = 45.3 \times \frac{2.78 + .24}{3.5 + .24} = 36.6.$$

Pressure at 4 inches,

$$c\ d = 45.3 \times \frac{2.78 + .24}{4 + .24} = 32.3.$$

Pressure at 4½ inches,

$$e\ f = 45.3 \times \frac{2.78 + .24}{4.5 + .24} = 28.9.$$

Pressure at 5 inches,

$$g\ h = 45.3 \times \frac{2.78 + .24}{5 + .24} = 26.1.$$

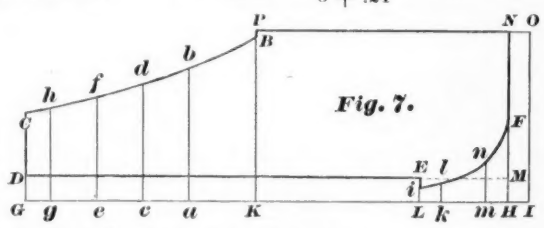


Fig. 7.

Pressure at 5.27 inches,

$$G\ C = 45.3 \times \frac{2.78 + .24}{5.27 + .24} = 24.8.$$

COMPRESSION CURVE.

Pressure at 4½ inches,

$$k\ l = 4.3 \times \frac{1.01 + .24}{.77 + .24} = 5.3.$$

Pressure at 5 inches,

$$m\ n = 4.3 \times \frac{1.01 + .24}{.27 + .24} = 10.3.$$

Pressure at 5.27 inches,

$$H\ F = 4.3 \times \frac{1.01 + .24}{.24} = 22.4.$$

Drawing curves $B\ b\ d\ f\ h\ C$ and $i\ l\ n\ F$ through the points determined by the foregoing calculations, the theoretical diagram $N\ P\ B\ C\ D\ E\ i\ F$, closely approximating the actual diagram, Fig. 6, is obtained.

The advantage of the theoretical diagram consists in its ready calculation by simple arithmetical formulas. Indeed, it is not necessary, in general, even to draw the theoretical diagram, since it is a geometrical figure of known form, and it is presented here merely for illustration.

The suppositions necessary for the calculation of a theoretical diagram, in the case of a proposed engine, cover some of the most important points of the design, such as initial pressure, back pressure, clearance, cushion, dimensions of cylinder, piston, and piston-rod, etc. In accordance with the plan already adopted, an attempt will be made to estimate, in advance, the probable performance of engines at the points of cut-off previously fixed, taking into account all the losses which occur in practice, and assigning proportions, etc., to render the results strictly

comparative. Evidently numerous assumptions must be made.

The points of cut-off assumed are—full stroke, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, and $\frac{1}{12}$. The engines are to be non-condensing; and the net horse-power in each case is to be 150; the piston speed 450 feet per minute; the absolute initial pressure 100 pounds per square inch; the absolute back pressure, including friction pressure, 17.5 pounds per square inch; and the fall of pressure, in pounds per square inch, from commencement of stroke to point of cut-off, is assumed to be:

For full stroke,		10
"	$\frac{3}{4}$ cut-off,	$7\frac{1}{2}$
"	$\frac{1}{2}$ "	5
"	$\frac{1}{3}$ "	$3\frac{1}{2}$
"	$\frac{1}{4}$ "	$2\frac{1}{2}$
"	$\frac{1}{6}$ "	2
"	$\frac{1}{8}$ "	$1\frac{1}{2}$
"	$\frac{1}{12}$ "	1

It is assumed that the average pressure, up to point of cut-off, clearance included, is the arithmetical mean of the initial pressure, and pressure at point of cut-off.

The foregoing assumptions represent average practical results. The piston speed is not excessive, the friction pressure is moderate, and the fall of pressure in the admission line is often more, and rarely less, at this piston speed.

For the compression, it is assumed that the ratio of compression shall equal the ratio of expansion, except for cases when this amount of compression would make the final cushion pressure greater than the initial pressure, in which event the ratio of compression is to be such as will make the final cushion pressure and the initial pressure equal.

The same relative dimensions will be chosen for the cylinders of all the engines, that the stroke shall be twice the diameter. Considering only the condensing surface of a cylinder, it would be better to make the stroke and diameter equal, since a cylinder of this form contains the maximum volume possible with a given surface. But by increasing the stroke the clearance ratio is reduced, also the number of revolutions per minute for a given piston speed, and practically the dimensions here assumed have found considerable favor.

It is necessary, in making allowances for the losses of heat, to know the amount of condensing surface, which consists of sides and heads of cylinder, two sides of piston, piston-rod, and surface of parts. Hence, the thickness of piston, diameter of piston-rod, and equivalent length of clearance must be given.

From the assumed data nothing is known in advance of calculation of the required cylinder dimensions, so that it will be necessary to make general assumptions for the above dimensions.

If it is assumed that the thickness of piston to the nearest half-inch, in inches, shall be equal to the square root of the diameter of the cylinder in inches, a fair approximation of the usual thickness will be obtained. The diameter of the piston-rod to the nearest sixteenth of an inch, in inches, can be calculated without serious error by the formula

$$.018 \times \text{diameter of cylinder, inches} \times \sqrt{\text{Initial pressure of steam, pounds per square inch.}}$$

This formula would not be absolutely correct for very long piston-rods, where the tendency to bend must be considered, but it gives fair values in most cases which arise in practice.

As to clearance spaces, it will be assumed that the actual clearance at each end of the stroke is $\frac{5}{16}$ of an inch, and that the port clearance adds the following equivalent lengths at each end of the cylinder, the values being chosen by examination of actual cases:

CLEARANCE SPACE, INCHES, IN EQUIVALENT LENGTH OF CYLINDERS.

	Cylinder.	Ports.	Total.
Full stroke	$\frac{5}{16}$	$\frac{5}{8}$	$\frac{15}{16}$
$\frac{3}{4}$ cut-off	$\frac{5}{16}$	$\frac{11}{16}$	1
$\frac{1}{2}$ "	$\frac{5}{16}$	$\frac{5}{4}$	$1\frac{1}{16}$
$\frac{1}{3}$ "	$\frac{5}{16}$	$\frac{13}{16}$	$1\frac{1}{4}$
$\frac{1}{4}$ "	$\frac{5}{16}$	$\frac{7}{8}$	$1\frac{1}{16}$
$\frac{1}{6}$ "	$\frac{5}{16}$	1	$1\frac{5}{16}$
$\frac{1}{8}$ "	$\frac{5}{16}$	$1\frac{1}{16}$	$1\frac{3}{8}$
$\frac{1}{12}$ "	$\frac{5}{16}$	$1\frac{3}{8}$	$1\frac{11}{16}$

It is assumed that the area of surface in the ports at each end of the cylinder is one and one-half times the area of the piston.

In calculating the steam consumption by piston displacement, a point will be chosen at $\frac{95}{100}$ of the stroke, and for the steam saved by cushion the final cushion pressure will be used; thus giving, for the first case, a point before the opening of the exhaust; and for the second, a point of stroke subsequent to exhaust closure.

With rare exceptions, the area of an actual diagram is less than that of the theoretical diagram; and in order to equalize the two, it is assumed that the actual pressure shall be ninety-five per cent. of the pressure calculated in the manner to be explained. This will give results which are readily attainable in practice, with good design.

In calculating the amount of heat lost by condensation, it is usual to estimate this condensation as a certain percentage of the total steam consumption. But the condensation is caused by the exposure of the internal surfaces of the cylinder to a variation of temperature.

1. In non-condensing engines, from the initial temperature of the steam to the temperature of the exhaust, about 212° Fahrenheit.

2. In condensing engines from the initial temperature of the steam to the temperature of the condenser, 120° Fahrenheit, on the average.

Now, under such circumstances, it is reasonable to suppose—and experiment confirms the supposition—that the condensation in a given time will be a definite amount, rather than a fixed percentage of a varying steam consumption; and an examination of such experiments as are available, where the actual condensation was measured, shows the following range of condensation in pounds of steam condensed hourly per square foot of internal surface for well-clothed cylinders without steam-jackets:

For non-condensing engines.... 10 to 20
For condensing engines..... 20 to 30

In the present calculation it is assumed that the condensation hourly per square foot of internal surface is 15 pounds of steam.

It is also assumed that the expansion and compression take place in accordance with Mariotte's law, and that the steam supplied to the engine in each case is dry; or, as it is commonly called, dry saturated steam. Such steam can always be supplied to an engine—even if the steam generated in the boiler is somewhat moist—by connecting a drum to the steam pipe, near the engine, with facilities for draining, or by using some one of the numerous steam separators or anti-primers in the market. Such attachments are rarely made without producing a marked gain in economy of steam consumption, because a very slight amount of water, mechanically entrained with the steam admitted to an engine, increases the steam consumption to a considerable extent.

An attempt has been made by some boiler manufacturers, seconded by several engineers of good reputation, to coin a new term in engineering literature, "commercially dry" steam; meaning thereby steam which does not contain more than three per cent. of entrained water—but users of boilers which furnish this quality of steam will do well to drain it before admitting it into the cylinders of their engines, if they wish to obtain economical results.

The assumptions just detailed are sufficient for the solution of the problem stated in a former part of this discussion, and the manner of making the calculation will next be explained.

LETTERS FROM PRACTICAL MEN.

The Boiler Explosion on the "Magic."

Editor American Machinist:

Nearly all the published accounts of the explosion of the tug boat "Magic's" boiler throw the blame—as usual—on the dead engineer. It is "assumed" that he "allowed the water to get dangerously low, and then attempted to replenish it." As that unfortunate man cannot defend himself, I wish to protest against the ignorant assumptions of paper engineers.

It is about time, I think, that engineers, for their own interest, should expose the "low water" fake theory. That old fraud has done duty long enough in protecting parsimonious boiler owners, and incompetent and dishonest "inspectors," to entitle it to a prominent place in the museum of mechanical humbugs.

The reports say that a piece of the crown sheet was "critically examined by superintendent W. A. Powers" after the explosion, and he "found evidence of low water." If that boiler had been "critically examined" before it exploded by a competent and conscientious man, it is more than probable he would have "found evidence" of "low tensile strength" instead of "low water," and also improper bracing, and a safety valve two or three sizes too small.

The proper way to test a boiler is to have a competent man look it over inside and outside, and subject it to the hammer test. The "hydrostatic test" should not be trusted implicitly.

A boiler explodes because the owner is too miserly to have it repaired or replaced, the "inspector" is incompetent or can be bribed, and the engineer will not "kick" too much, through fear of a discharge.

Peter Gibbons.

Scale in Boilers.

Editor American Machinist:

If there is one thing more than another that the average engineer is careful with, it is the use of boiler compounds. With an open exhaust heater and an overworked boiler, and using water from a drilled well sixty feet deep in limestone, I have had to be rather careful to avoid scale and foaming. I offer some notes from my experience under the above conditions.

In using compounds containing sal soda I had to use 40 per cent. more cylinder oil, and this invariably re-acted, through the heater and feed water, on the boiler, and produced foaming. I have used six compounds warranted to cure foaming with above results. The compounds were tannic acid and soda.

Changing to the use of crude oil, I found that the volatile parts went over to the engine, and I saved 10 per cent. cylinder oil over when using nothing, and 50 per cent. over the use of sal soda. There is a peculiar easy manner of making steam that is very different from the same boiler using sal soda. The results on scale are as follows:

In changing to a different solvent the results for a few runs were very good, and then it seemed to lose its virtue while using double quantity; result, foaming. With crude oil used continually I have had scale form $\frac{1}{8}$" thick, but never any thicker, as it came off clean and was very porous. I prefer oil to any acid or alkali solvent. For cleaning a scaled boiler I would recommend alternate use of oil and sal soda, but the remedy is heroic. If the boiler is not clean in two weeks I miss my guess. I have tried kerosene and found it too volatile to be of value in a limestone district. In summing up the results, I believe:

First, With an open exhaust heater use only the best cylinder oil, which should be at least 80 per cent. petroleum.

Second, If the crude oil does not keep the scale all out, alternate one run with sal soda, using it carefully.

Now I only offer this as my experience, knowing full well that the conditions are never absolutely the same. But I know of a plant (in this city) where the boiler is not worked up to its full capacity, and which is kept entirely free from scale, using hard water, by the alternate use of sal soda and crude oil.

T. T. Parker.

Springfield, Ohio.

Wrought-Iron Frames.

Editor American Machinist:

The use of wrought-iron plates and angles for engine frames and braces has been urged somewhat strongly of late in your columns. However practicable and useful this employment of wrought-iron members may be for such work—and for many reasons it is desirable—there are some objections to it which are worthy of notice and of brief comment.

One of these is the fact that in the rolling of all the pieces likely to be used in engine frames, or similar construction, no outlines can be produced (with slight exception) except such as are of parallel width and thickness. Hence, when tapered or enlarged forms are to be employed in the structure, they can be obtained only at the expense of shearing and a waste of material.

Another objection results from the excessive loss of material due to the punching (or drilling) which must be done for securing the plates, and framing members to each other. This loss may be looked upon as indirect (though real) in that the parallel outline must be used, and paid for, however much the actual cross-section is reduced by the needful rivet holes, placed too, as they often must be, at a distance from the central axis of the member.

Another objection is the extreme difficulty of filling the holes thus punched with rivets that shall be at once accurately body-bound their whole length, and solidly headed up, as they must be, to be worthy of the slightest confidence as rivets.

One other condition should be named, which involves sometimes considerable expense, and something also of a wasteful use of material. This arises from the impossibility of making, or leaving, on the parallel outline of the wrought-iron pieces, anything corresponding to a chipping strip, or to a raised boss, as for a faced seat under a nut or key. This must lead, in many cases, to the facing (often by hand) of comparatively broad surfaces at the sacrifice sometimes of effective cross section, usually after the riveting has been finished and the piece may have become too unwieldy for a planer.

The lack of dead weight in some frames (and of absolute stiffness) however strong they may be, are also worthy of mention.

Pittsburgh, Penn. P. Barnes.

Hemp Rope Transmission.

In the discussion of this "Topical Question" by the Mechanical Engineers, at the recent meeting at Nashville, Tenn., the prevailing opinion, so far as expressed, was that the radius of the groove at the bottom should be considerably less than the radius of the rope, so that the latter should not bottom in the groove. The total depth of the groove, according to sketches shown, was equal to nearly twice the diameter of the rope, the boundaries of the sides of the groove above the circular bottom being circles of large radius, so as to afford more bearing for the rope than if the boundaries were straight lines. At the periphery of the wheel the grooves were about 20 per cent. wider than the diameter of the rope.

Opposed to this view, however, one member believed that the groove should be, at the bottom, the same radius as the rope, so that the latter would bottom; the rope should pass times enough around the pulley to receive the necessary friction. His opinion was that when adhesion of the rope was brought about by permitting it to wedge itself in the groove, that the latter clung in the groove beyond the point of tangency, and when it left the groove produced a jerky motion. This was said by others not to be the case if the angle was not too small.

The driving and driven pulleys, it was said, should not be less in diameter than 35 times the diameter of the rope. The guide pulleys should have large, easy grooves, the rope, of course, bottoming freely.

The rope should last from three to five years.

Mr. Minot thought long splices, six to ten feet in length, the best, while Mr. Lamphere favored short splices. Both spoke from experience. On the whole, the burden of evidence seemed to favor long splices. Long splices, it was said, should be made so nicely that it was nearly impossible to find them, but it was admitted that short splices thickened the rope a little at the splice.

The following was given as the stress on ropes in actual use—not as a rule, but to

show what certain ropes were doing satisfactorily :

Dia. of Rope in Inches.	Working Stress in Pounds.		
1½	247½		
1 1/16	220		
1¾	278½	330	363
2	495		
2 1/16	256	330	349
2¼	205	330	

The above figures were from the experience of Messrs. Pearce, engineers, Dundee, Scotland.

The new organ now being erected in the permanent exposition building at Cincinnati, Ohio, is by far the largest in this country, if not in the world. The room in which it is being erected will seat 5,000 people comfortably, and about double that number can get in by crowding.

Riehlé Bros'. Torsional Testing Machine.

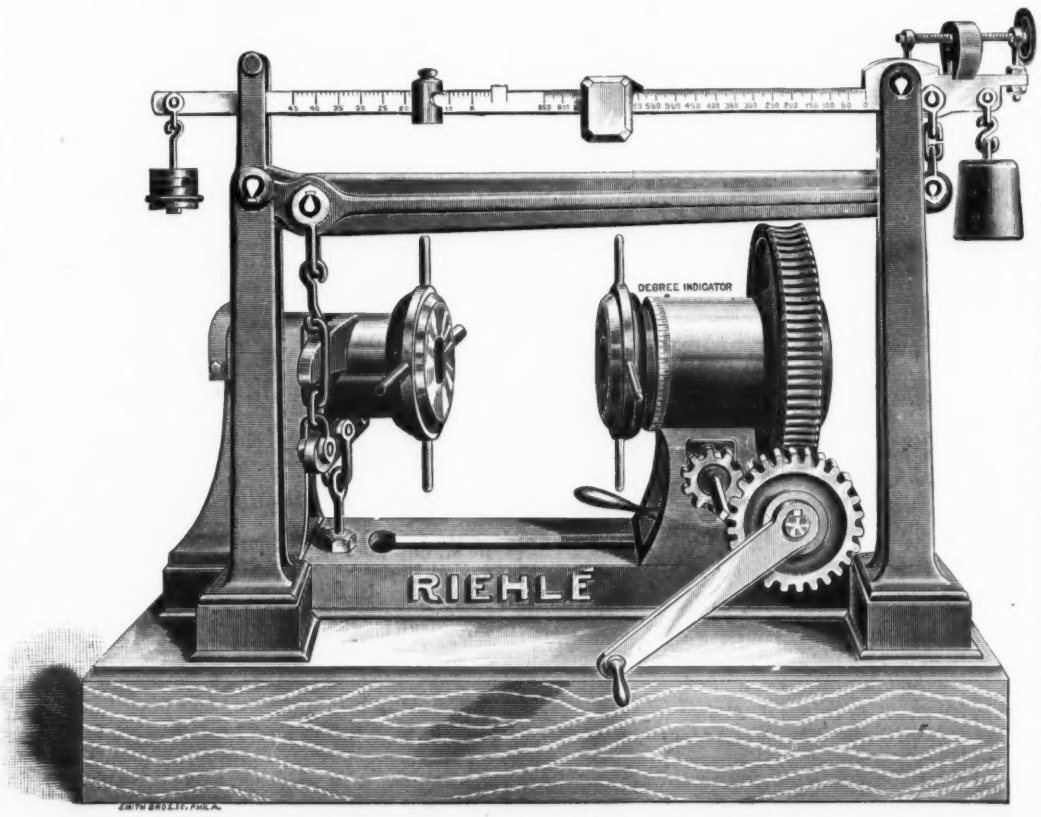
The illustration represents Riehlé Bros.' torsional testing machine for testing specimens of materials by torsional or twisting strains. It is constructed entirely of iron, brass and steel, and is of handsome design and finish. It consists of one fixed and one adjustable head. The fixed head, carrying self-centering grips, has arms of one foot in length projecting from either side of the grip-head (which is supported on a knife edge). To prevent the grip-head from lifting from its position, the one-foot arms are connected to an equalizing lever underneath, and this in turn connects with the weighing beam, where the strain is recorded in foot pounds without any calculation on the part of the operator.

The movable head can be moved up to the fixed head to take in specimens a few inches in length, or moved away to take 20-inch specimens, or of any desired length. This head has self-centering grips, and also has graduation marks to give the number of degrees the free end has been moved. The power is applied by hand at either of the two points, on the larger wheel giving greater speed and less power, or on the smaller wheel giving decreased speed and greater power.

A slight modification of this design enables belt power to be applied instead of hand power. The result of a test is at once apparent in foot pounds on the weighing beam, and the traverse of the moving end of the bar is recorded by the graduated head and indicating figure.

The dimensions of the machine are as follows : 3 feet 4 inches long, 4 feet 9 inches high, 24″ wide. It weighs about 1,200 pounds and is about 5,000 pounds capacity. It will test specimens in round or square shape up to 20 inches in length.

This machine is built by Richlé Bros., Philadelphia, Pa., who will furnish any further information desired.



RIEHLÉ BROS'. TORSIONAL TESTING MACHINE.

In an obscure corner of a New York daily, we notice an announcement in a few lines that a freight train on the Milwaukee and Northern Railroad went through a bridge over the Michigamme river, and the fireman and the head brakeman were killed. Such occurrences have become very common of late, and the killing of a few railroad men more or less is a small matter and attracts very little attention. Yet it would have been just as easy for a passenger train to have gone through that bridge and killed a few passengers, in which case the small item would have been expanded to fill a column with big head-lines on the first page.

The Loss from Clearance.

BY C. L. REDFIELD.

We have been taught that the clearance of an engine means loss, and the greater the clearance the greater the loss. While most of us are, doubtless, firm believers in this idea, in spite of the occasional assertion that compression is a complete remedy, there are comparatively few who can give a satisfactory reason beyond a reference to corroborating experience. A few simple diagrams may, however, be made to thoroughly demonstrate that clearance is attended by loss, in spite of everything that can be done, while at the same time they will show what remedies are efficacious, and to what extent.

The existence of any law or principle, whose effects vary according to circumstances, is generally more easily demonstrated by assuming extreme conditions, and then comparing results, than by any other means. For the sake of convenience, we will assume a cylinder capacity of one cubic foot, first with a clearance of 100 per cent., and then with no clearance at all. In general, it may be said that in non-condensing engines the greater the expansion, provided it is not below atmospheric pressure, the greater will be the economy. We will assume, for the present, that the nearer compression can be carried to the initial pressure, the more it will also add to economy.

Fig. 1 shows a diagram drawn under the most favorable conditions, when the clearance is 100 per cent. of the piston displacement. The horizontal lines 0, 15, 30, 45 and 60 represent absolute pressures, and not those above atmosphere. The assumption is that to obtain the greatest possible economy both expansion and compression are carried through the entire stroke. The work performed is represented by the shaded area. The steam used each stroke is that required to fill the clearance space from 30 to 60 pounds. A reference to the steam tables will show that a cubic foot of steam at 30 pounds' pressure weighs 0.0,755 pounds, while that at 60 pounds' pressure weighs 0.14,566 pounds. From this we learn that the steam admitted each stroke is 0.07,016 pounds, or a little over 48 per cent. of a cylinder full at 60 pounds' pressure.

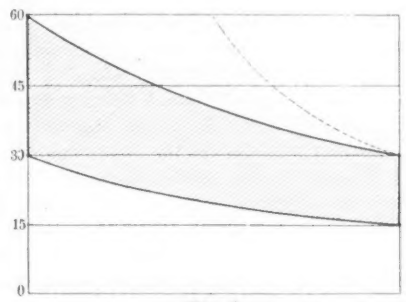


Fig. 1.

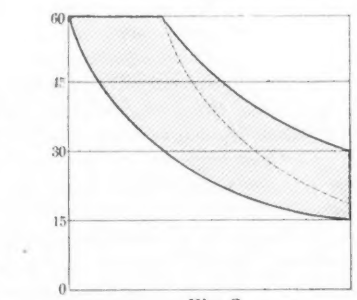


Fig. 2.

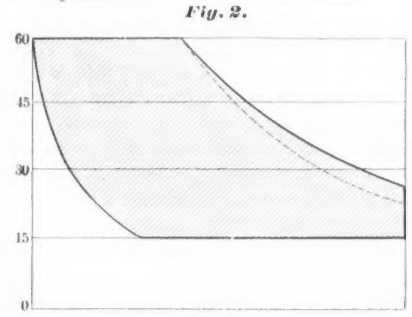


Fig. 3.

If, instead of having 100 per cent. of clearance, we had no clearance whatever, the admission of this 0.48 of a cylinder full of steam would give us a steam line extending about one-half of the stroke and the expansion curve shown by the dotted line. The area inclosed between these lines and the former expansion line shows the gain in power that will be obtained on the steam side. As the condition of no clearance implies no compression, there will be the further gain on the exhaust side of the area between the former compression curve and the line of 15 pounds' pressure. The difference between these two diagrams is so plain as to need no further comment beyond the statement that, under the conditions assumed, a given amount of steam produces about 68 per cent. more power when used without clearance than when the clearance is 100 per cent.

In case no compression were used with a clearance of 100 per cent., there would be a gain in power represented by the area between the compression line and the line of 15 pounds' pressure, or about 25 per cent. But to accomplish this would require nearly 50 per cent. more steam, so we see that compression is a partial offset against clearance.

The assertion that compression is a complete remedy for clearance is based on the assumption that compression is carried up to the initial pressure. The error of this is plainly seen in Fig. 2. In this case the clearance space is one-third of the piston displacement, and is completely filled by compression. The cut-off is represented at one-third, so that the steam used, both with and without clearance, is one-third of a cylinder full. The work performed in the case of clearance is represented by the shaded diagram. In the case of no clearance the expansion curve would follow the dotted line, showing a loss on the steam side of the area between these two expansion curves. This is more than compensated for by the gain of the larger area below the compression curve. Thus we again see that no clearance has the advantage of clearance in the point of economy.

It might appear that this was due to the fact that compression was carried through the entire stroke, while expansion was only carried through part of it. A glance at Fig. 3 will show that this is not so. Here the clearance is assumed at 10 per cent., compression is carried through three-tenths of the stroke, and expansion through six-tenths, yet the gain on the expansion curve is less than the loss on the compression curve.

If we imagine the cut-off to be later, the area included between the expansion curves of clearance and no clearance will be less, and if steam follows full stroke this area will be reduced to nothing. From this we see that the greater the expansion the more will the loss of efficiency due to compression be overcome. If the expansion be carried down to atmospheric pressure, then the increase of pressure during expansion will equal the loss of pressure during compression carried up to the initial.

To sum up the results, we find that clearance is a loss of steam ; this loss of steam may be changed into loss of efficiency by compressing to initial pressure ; and this loss of efficiency may be overcome by a corresponding gain of efficiency by expanding to atmospheric pressure. In other words, compression to initial, accompanied by expansion to atmospheric, is a theoretically perfect remedy for clearance. These are conditions that are practically unattainable, and the further practice departs from them the greater will be the loss from a given amount of clearance. In the extreme case of Fig. 1, the expansion is two-thirds of the way from initial down to atmospheric pressure, and compression is one-third of the way up. This is probably not far from average practice, and represents a loss of 68 per cent. of the clearance. We may therefore assume that in good practice, as we know it to-day, the actual loss is not far from 40 or 50 per cent. of the clearance.

There is, furthermore, a practical loss from clearance, which not even the theoretical perfection before mentioned can overcome. What the amount of this loss is may be set down as an unknowable quantity, but its actual existence may be seen from a further consideration of Fig. 1. An inspection of the diagram will show that in expanding to a given pressure a reduction in the amount of clearance allows a later cut-off, and hence gives a greater power from a definite size of cylinder. We therefore can see that where a definite power is required, clearance compels us to use a larger cylinder than would be otherwise necessary. This means increased cost, increased friction, and increased loss by radiation, and although the total may be a small quantity, it is, nevertheless, a reality.

That mysterious individual, "a well-known engineer," has again been interviewed by the reporter, and, as a result, an item is making the rounds which purports to tell how much it costs to stop a train. Among the other remarkable statements made is one that "there is required about twice as much power to stop a train as to start one." We would like to know just what such a statement is based upon. We had an impression that the power required to stop a moving body of any kind was exactly equal to the power required to put it in motion.

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Grades of Machinery.

There is, perhaps, no term which is more indefinite than the expression, "first class workmanship," as applied to machinery. Scarcely two shops have precisely the same standard of workmanship which they call "first class," and a job which in one shop would be called "first class," would, in another shop, be considered only ordinary, or worse.

If two machines of a similar nature be ordered from different makers, both claiming "best design and workmanship," "large and long bearings," "ample driving power," etc., it will often be found that there is a vast difference between the two machines in these respects, thus making it a very obvious fact, that if one of them is first class in design and workmanship, then the other one cannot be; while if the one has only ample bearings and driving power, the other must be deficient in these respects.

In some few cases this simply means that one of the builders is not honest, and that he knows he is not furnishing what he agrees to furnish; but in the vast majority of cases it means only that the two builders have entirely different ideas as to what constitutes the ideal in these respects, and that both of them honestly think they have attained it.

A large part of the trouble and annoyance which must perhaps be considered a necessary accompaniment to any business, is, in the manufacture and sale of machinery, caused by the fact that the maker and the buyer often have entirely different ideas about these matters, and where the maker's ideal is much lower than the buyer's, there is dissatisfaction with the machine, while, on the other hand, if the maker's ideal is much higher than the buyer's there is dissatisfaction with the price, either circumstance interfering with present or prospective business relations.

Although it is of course a fact that differences in methods of manufacture, management of shops, amount of business done, and cost of materials, have much to do with fixing the price at which the finished machine can be sold, yet it is equally a fact that this difference in the standard of workmanship has, in many cases, more to do with it than all other causes combined. Any discriminating mechanic can find abundant proof of the truth of this statement in almost any branch of the machine business; in engines, in boilers, or in machine tools.

Taking the case of small lathes, for instance, there are many builders of them, and a man wishing to buy one may take his choice from a great many different varieties at as many different prices, the highest priced one costing about three times as much as the cheapest, and the maker of each one will honestly claim that his lathe is first class in every respect. Now, notwithstanding the buyer thinks he wants a first class tool, he will, unless his standard in such matters is high, buy the cheaper one, much to the disgust of the high-priced builder, who knows that the man has not purchased the kind of tool which he had declared he must have.

There are some reasons for believing that builders of machinery might learn a lesson on this point from some of the watch factories, which would prove beneficial to all concerned.

There are numerous grades of watch movements made in the same factory, and a buyer may select the make of watch which he prefers and then select the grade best suited to his requirements and his pocket-book. The countryman who merely wants a big watch, and one which will keep time closely enough so that he may know when to start out of town of a Saturday afternoon so as to get home in time to "do the chores" before dark, can find a movement to suit him for about eight dollars, and there is no attempt to convince him that it is the best watch made, nor that he ought to spend two hundred dollars for a movement which he would not appreciate, and would only ruin. On the other hand, there is no attempt to sell to an engineer or conductor, or to a professor of astronomy, an eight dollar watch, and convince him that it is first class; but each one is suited according to his conception of a watch, and pays accordingly, each knowing that for a different price he may obtain a different watch.

There would undoubtedly be some advantages in the adoption of a similar plan by the builders of lathes and other machinery, and it would do away with much compromising and a good deal of strain upon conscience.

A man who builds threshing machines does not need such a lathe as is positively necessary for the man who builds watch tools; the requirements are altogether different, and yet almost any one of our tool builders will undertake to furnish a lathe suited to either purpose, and there will be no difference in them if they come from the same shop; in fact, they may be selected at random from a warehouse stock. A natural consequence of this way of doing business is an effort to build a lathe fine enough for the finest work, and yet strong enough for the heaviest work, and to furnish it to everyone at a price which the threshing machine man is willing to pay, and which, in fact, is all he ought to pay for the kind of lathe which he requires, and which is to be run by the kind of mechanics he usually employs. Yet that price is far below what ought to be obtained for a really fine lathe, capable of doing the best work.

We think this is a matter worthy of consideration by tool builders and other manufacturers of machinery, and have little doubt but that the practice of building two grades of similar machines by the same maker, would, in many respects, prove advantageous. We should hope that it would prevent a good deal of unfair competition, and have a tendency to put some branches of the business upon a more satisfactory basis.

Beating the Bell Punch.

One of the latest examples of mechanical ingenuity comes from Chicago and the invention (which we scarcely think is patented) is called a brother-in-law. It is placed under the vest, one of the buttons of which is detached from the garment and attached to a string so that when the button is pulled slightly, a bell is rung which sounds precisely like the bells which are in the conductor's punches used on the street cars. And many of the gay and festive "conductors" have, by the assistance of their ingenious brothers-in-law, been making very fair wages, so that a falling off in receipts was noticed by the company, which led to the discovery of the scheme.

Of course stealing is a bad business, whether it be done by a millionaire or a street car conductor, but the fact is that the ingenious device to prevent stealing known as the "bell punch," is a direct challenge for the invention of something more ingenious to beat it, and every ring of its bell is an announcement to all who hear it, and a reminder to him who carries it, that the company places no confidence in him whatever, and, being thus branded as a man utterly unworthy of being trusted, it is in accordance with human nature, however lamentable the fact may be, that he should, "having the name, seek the game."

There is no doubt whatever that a large majority of the men who were detected in this business were entirely honest and fair in every other business relation where some confidence was placed in them, and they were not advertised as rascals.

It is turning out to be with natural gas as with most every other natural product, those who have been able to secure the ground which produces it, and the franchises for piping it into the cities where it is to be used, are beginning to squeeze the people who use it, and measures are being taken to see if there is any relief to be had. In Allegheny, Pa., numerous meetings have been held on the subject, and it is proposed to take the matter into the courts, which looks like a case of locking the stable after the stealing of the horse.

If the tariff discussion in Congress and elsewhere is profitless in most instances, there is one respect in which it is helping to spread some interesting information; that is, in bringing out the fact that American workmen produce much more in the same time than British workmen. We have at different times published opinions to that effect of American mechanics who have opportunities to observe this, and this fact seems to be borne out by the opinions of everyone who has studied the subject. For example, Mr. Russell, of Massachusetts, gave recently, in the course of the tariff debate, an interesting account of the working in England of a Yankee invention for soling and heeling shoes. The machines were introduced on royalty, but the profits to the company controlling the invention were not up to the expectations of the stockholders. An agent was sent to look into affairs; he came back and reported that the British workmen with the same machine would do no more, week by week, than 47 per cent. as much work as the American workmen. The British workman wouldn't work as hard, worked less hours in the week, and fewer days in the year.

The *Progressive Age and Water Gas Journal* has moved its headquarters from Philadelphia to New York, and has been changed from a monthly to a semi-weekly. Several other important changes have also been made. We congratulate our contemporary on these evidences of prosperity.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(260) J. M., Peshtigo, Wis., asks: Will one lubricator feed two cylinders on a locomotive? I have generally seen two. *A.*—One lubricator is now used for both cylinders. These lubricators are placed in the cabs.

(261) E. J., Buffalo, N. Y., asks: Is it impracticable to punch holes of smaller diameter than the thickness of the iron that is being punched? *A.*—No. With a properly made punch there is no trouble in punching iron twice as thick as the diameter of the hole, and with special appliances much more than that can be done.

(262) J. V., Philadelphia, asks: In which direction should the laps of a leather belt run on to the pulleys? *A.*—It is a little better to put the belt on so that the pulleys will have a tendency to make the ends of the laps lie flat and not strip them up; but practically it is a matter which is seldom given any attention in the shop, and with good belts makes little difference.

(263) W. J. C., New Brunswick, N. J., asks: Is the length of the cavity of an ordinary slide valve equal to the length of the steam ports? *A.*—Yes. 2. Please refer me to some treatment on the construction, management, and repairing of the Westinghouse automatic air brakes. *A.*—We do not know of any other book than the catalogue of the Westinghouse air brake, which contains the required information.

(264) D. F. S., Boston, Mass., writes: Please advise a young man the best things to follow up from a machinist. He is a good machinist but would like to be something better. If mechanical engineering, what should he study, and how should he start out. *A.*—Study arithmetic; then geometry and practical drawing. After you have made some advancement take up algebra, and also natural philosophy. Procure only elementary books on the foregoing subjects; when you have mastered these let us hear from you again.

(265) G. M. T., Youngstown, Ohio, writes: I am seventeen years of age and intend some day to be a mechanical engineer. I am now in second year of the high school. What do you think would be the best thing for me to do, stop school now and go for a few years in a machine shop or drafting office and then go to a technical school, or first go to a technical school, and get my practical education afterwards. *A.*—Do not leave the high school; get all the education you can. As to whether first to enter the machine shop or technical school, you must use your own judgment, and be guided by the advice of your teachers and friends who are better acquainted with you and your abilities than we are.

(266) A. H., Indianapolis, Ind., writes: I have a small engine with a cylinder 3 inches bore and 4 inches stroke, ports 1¼ inch × ¼ inch. I would like to know what changes would have to be

made to make this 1½, or if possible a 2 horse-power engine. *A.*—The cylinders are entirely too small for the power you wish to obtain. You will need larger cylinders proportioned to the steam pressure and number of revolutions required. 2. I have a boiler 4 feet high and 2½ feet diameter, carrying 60 pounds of steam pressure; it has five flues 3 inches diameter and one flue 3½ inches diameter. Do you suppose this engine will be powerful enough to run a boat 18 feet long and 8 feet wide with a screw propeller if possible? *A.*—Engine and boiler are not large enough; we cannot advise you as to size, since you do not give draft of boat and speed required.

(267) A. B. C., ——, Wis., writes: Please explain the difference between the method of manufacture of what is known as "Mushett's" steel, and the ordinary tool steel, and give simple instructions for the blacksmith to go by in working the Mushett's steel. *A.*—We cannot give the method of manufacture of this steel and believe it is known only to the manufacturers, though there is a steel now made in this country, which possesses all the characteristics of the "Mushett," and is by some considered superior to it. It is worked very much the same as other steel, except that it is more difficult to forge, on account of its extreme hardness, for which reason tools of the most simple shape only should be attempted with it, by forging. After forging it may be thrown down and allowed to cool, and when cold will be hard. Any good blacksmith accustomed to tool forging will quickly learn how to handle it, and how far he can go in forging it.

(268) M. D. B., Litchfield, Conn., writes: The enclosed cut represents a feed trough. You will notice the top of each wire is bent, forming a harp loop, so the fowls cannot injure themselves should they try to get into the trough. I should prefer a globular head on the top of each wire in place of the loop. Will you please inform me whether or not this is practicable without the aid of expensive machinery? Are there any shops equipped for doing such work where I could get them made without ordering in large quantities? *A.*—It seems to us, the cheapest and best way would be not to forge the globular head on the wire, but cast it to the end. Any foundry will be able to do such work for you without having to make expensive equipments for the purpose. 2. Does the temperature of the air increase as the pressure? *A.*—Within practical limits the temperature increases as the pressure. 3. To what pressure is it necessary to compress air of atmospheric pressure to raise the temperature from 40 to 212 degrees? *A.*—To 20 pounds absolute pressure, or 5 pounds above atmospheric pressure.

(269) L. W., Bellefonte, Pa., asks: Is there any power gained by having a double screw, the pitch being the same, say two threads to the inch, and if not what is the advantage in having them double, as in globe valve stems? *A.*—There is no *power* gained by any screw, either single or double. The power which is exerted by means of a screw is always just equal to the power which is applied to it, minus the friction. But disregarding friction, the *force* which the screw will exert in moving, is inversely as the distance moved by the screw during one revolution, compared with the distance moved through by the applied force during one revolution. This is true whether the screw be single double, or triple. If the force applied to move a screw moves through a distance of 10 inches during one revolution, while the screw moves through the nut one inch in the same time, then, barring friction, the *force* will be increased tenfold. The advantages of a double thread are that it gives the desired movement of the screw, without cutting in as deep as would be necessary if a single thread of standard proportion were used, and yet gives the wearing surface to the screw and nut which would be obtained by cutting a single thread of half the pitch.

(270) J. K., Parkdale, Canada, asks: When the driving wheels of a locomotive are put on the axle with cranks at right angles, can the wheels be turned to either side, or is there a right and left-hand side? *A.*—The wheels should always be put on the axle in a position in which the right-hand crank will lead or go ahead of the left-hand crank when the engine is running forward. With the wheels pressed on the axle in this position the axle and wheels may then be turned end for end under the engine, without affecting the action of the crank; that is to say, the right-hand crank will always lead, no matter which wheel is placed under the right-hand or left-hand side of engine. If the wheels are pressed on the axle in a position in which the left hand crank takes the lead when the engine is going ahead, no amount of turning the axle end for end under the engine will bring the cranks in the correct position. You can very easily convince yourself of this fact by taking two pieces of wire, and turn the ends of each at right angles to each other; in one wire turn the ends, so that when the wire revolves in the direction of the hands of a watch, the right-hand end of the wire will lead; turn the ends of the other wire so that the left-hand end of the wire will lead when revolved in the same direction, and note the difference. Cranks should be put on the axle to correspond with the position of the ends of the former wire.

(271) G. B., Corpus Christi, Texas, writes: Would you please tell me how many feet of 2 inch pipe it would take to make a condenser for an 8 inch by 12 inch steam engine running at 120 revolutions, steam pressure in boiler 80 pounds, throttling governor. I wish to make a condenser in the form of a box coil to condense the steam of engine for freezing into ice, and would run it without an air pump. How many pipes 6 feet in length would it take of 2 inch pipe with water running over them in a spray to cool them? I have now a condenser that has a number of small tubes which are packed at the ends with lead bushing, and it gives me a great deal of trouble. *A.*—You will need about 200 square feet of condensing surface. If you insist on using a pipe 2 inches in diameter, you will need 384 feet, or if cut in 6 feet lengths you will need 64 pipes. The condensing surface here given is larger than that which would be obtained by rules for determining the condensing surface in marine engines, but we believe that a comparatively large surface will answer your purpose better. It seems to us that a two inch pipe is too large in diameter. With brass pipes ¾ of an inch diameter, you can obtain the same amount of condensing surface in a condenser of smaller compass and at less cost. If these small tubes are properly packed by a mechanic, they will be perfectly tight and not give you any trouble.

(272) H. A., Ottawa, Canada, asks: Would you kindly inform me how phosphor bronze is made? *A.*—Ordinary phosphor bronze consists simply of any alloy of bronze or brass, or any ternary alloy of copper, tin and zinc which has been given exceptional purity and excellence by skillful fluxing with phosphorus. It is also supposed that the presence of phosphorus is useful in giving the tin a crystalline character which enables it to alloy itself more completely and strongly with the copper. The amount of phosphorus in an alloy depends on the purposes for which the phosphor-bronze is to be used. The minimum and maximum percentages of phosphorus in phosphor bronze are 2 and 4. Five sorts of phosphor bronze, however, are considered to answer all requirements. 0. Ordinary phosphor bronze of 2 per cent. of phosphorus. 1. Good phosphor bronze of 2½ per cent. of phosphorus. These two numbers are superior to ordinary bronze and steel in all cases. 2. Superior phosphor bronze of 3 per cent. of phosphorus. 3. Extra phosphor bronze of 3½ per cent. of phosphorus. 4. Maximum phosphor bronze of 4 per cent. of phosphorus. In making phosphor bronze or copper alloys of all sorts, the copper should first be melted in the usual way, with a cover of charcoal put over it as quickly as possible. After the required quantities of tin, zinc, etc., have been added, or in case of gun metal or brass scrap, after the latter has been completely melted, the small exactly weighed quantity of phosphor copper is added, while the metal is continually stirred. For stirring, a graphite bar, a strip cut from an old plumbago crucible, or a bar of retort carbon, should be used. The stirring has to be done carefully, and the metal then freed of the coal and scoriæ floating on the top; it should be poured before the surface begins to be covered with a skin. The latter point and the careful stirring cannot be too urgently recommended. For further particulars, strength and uses of phosphor bronze, see "Materials of Engineering," Part III., by Robert H. Thurston, from which the foregoing has been taken.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

See Grant's Gear advt. on back page.

Link-Belting.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link Belt Machinery Co., Chicago and N. Y.

Taper attachment on all lathes Lodge, Davis & Co.

Compound rest on all lathes Lodge, Davis & Co.

Power cross-feed on all lathes Lodge, Davis & Co.

Large hollow spindle on all lathes Lodge, Davis & Co.

Automatic stop on all lathes Lodge, Davis & Co.

See special ads. pages 15 and 16 Lodge, Davis & Co.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass

Lamb Knitting Machine Co., Chicopee Falls, Mass.

Machine work and pattern making. Anderson Machine Works, Peekskill, N. Y.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Improved fine tools for mechanics, manf'd by L. S. Starrett, Athol, Mass. Send stamp for full list.

"Swift" Sight-feed Lubricator; no glass tubes; simple, reliable. Swift Lub'r Co., Elmira, N. Y.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Burnham's turbine wheel is sold at net price to mill owners. Catalogue free. Address York, Pa.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N. Y.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Silk wiping towels are better and cheaper than waste. S. A. Smith, 23 South Canal st., Chicago, Ill.

The bulldozer, a new departure; forging by pressure. M't'd by Williams, White & Co., Moline, Ill.

Ice and Refrigerating Machines, 124 built, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

For the latest improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Engine lathes, hand lathes, fine tools, files and supplies for machinists and other metal workers. Frasse & Co., 92 Park Row, N. Y.

Artesian, salt and oil well pumps; sucker rods and deep well supplies; wrought-iron tubing and steam pipe. Hardwicke & Ware, Buffalo, N. Y.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Model engines and castings. Prices $3.75, $4.75 and $5.75. For descriptive circular apply to Montgomery & Co., 105 Fulton street, New York city.

Curtis Pressure Regulators, Curtis Return Trap, Curtis Damper Regulator. See May 5, p 14. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Robertson's damper regulator; no diaphragms, springs or packing; the cheapest good regulator in market. Hine & Robertson, 45 Cortlandt st., N. Y.

Machinists' supplies, brass goods, m'f'rs supplies, polishing materials, all kinds wire, metals, etc., in any quantity. Jordan & Gottfried, 208 Canal st., N.Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st, N. Y. Send for des'n.

Patent Att'y. R. G. DuBois, 916 F. st., Washington, D. C. Reliable service at reasonable rates. Send for 38-page pamphlet containing list of references.

The Holley Manufacturing Company, of Lockport, N. Y., will send on application, their pamphlet illustrating pumping machinery and reports of duty trials.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches; working drawings for the transmission of power by steam, water, air and electricity.

Parties requiring milling machine or screw machine work furnished, in large or small quantities, please write to the manufacturers, E. E. Garvin & Co., 139, 141, 143 Centre st., New York City.

The Dieble Mfg. Co., Philadelphia, Pa. mfrs. of the Challenge emery grinding and polishing machinery, invite correspondence with all needing this class of machinery. Catalogues and prices on application.

Contract work of all description executed promptly and on reasonable terms. Parties wishing gray iron castings in large quantities can make money by corresponding with us. The Rawson Mfg. Co., Hornellsville, N. Y.

For the manufacture of
Patented articles in line of machine work;
Specialties in fine light machinery;
Accurate cam cutting,
Address Wardwell S. M. Co., Woonsocket, R. I.

Jas. D. Cardell & Co., 1900 Passyunk ave., Phila., Pa., will remove June 1st to Rising Sun Lane and North Penn. R. R., where they will continue manufacture of coils of wrought-iron pipe for ice machines, soap works, boilers, tanks, etc.

Hot Water Supply. A practical treatise on the fitting of hot water apparatus for domestic and general purposes. By F. Dye. 82 pages with 25 illustrations. 12mo., cloth, $1. Send for catalogue. E. & F. N. Spon, 12 Cortlandt st., N. Y.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price $2, post paid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

The series of articles by J. G. A. Meyer, on "Practical Drawing," now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including April 7, 1888 issue, 47 articles have been so far published. Copies containing these articles, sent by mail to any part of this country or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

"Modern Locomotive Construction," by J. G. A. Meyer. The above series of articles now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 61 articles have thus far appeared up to and including the March 31, 1888 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES

An electric light plant is talked of at Dalton, Ga.

Erie car shops are to be located at Youngstown, Ohio.

The Georgia Electric Light Company will increase their plant at Atlanta.

Carrollton, Ga., offers free sites to all new manufacturing concerns.

J. D. Mitchell & Co. contemplate organizing a company to start an ice factory at Bristol, Tenn.

The Sherman Iron Works, of Sherman, Texas, have changed proprietors, and are to be enlarged.

It is announced that the Colorado Coal and Iron Company will hereafter make steel instead of iron rails.

Charles H. Wing & Son have opened a machine job shop and commission business at Carthage, New York.

At Carrollton, Ga., the question of a cotton factory is being agitated. A. B. Hills is connected with it.

J. F. Good is interested in starting a leather fly net factory, also a whip factory, at New Cumberland, Pa.

At Galveston, Tex., the Gulf City Co-operative Manufacturing Company has been organized, with a capital of $50,000

The Bass Foundry and Machine Works, Fort Wayne, Ind., are adding new machinery to their car wheel department.

The Sterling Emery Wheel Company have removed their New York City warerooms to larger quarters at 17 Dey street.

At King's Mountain, Ga., R.T. Gansler is preparing to develop a tin mine, and a mica mine is being developed by Mr. Easterling.

A bill has been introduced into the Kentucky Legislature appropriating $60,000 to rebuild the recently burned shops at the penitentiary.

Lodge, Davis & Co., Cincinnati, Ohio, have just closed a contract for the entire outfit for machine shops of the Mt. Auburn cable road of Cincinnati.

The shops of the Winchester Repeating Arms Company are running twelve hours per day. They have recently received a large order for sporting rifles.

The question of water-works is being agitated at Marion, Ala.; Winchester, Ky.; Dyersburg, Tenn.; Pulaski, Tenn.; Lexington, Va.; and Moundsville, W. Va.

E. T. Fleming is secretary of a new company which is to operate a foundry and machine shop at Nashville, Tenn. It will be called the Capital City Machine Company.

Sales of the Babcock & Wilcox boiler for March and April aggregate about 10,000 horse-power. A good proportion of the sales were from foreign countries, and were from duplicate orders.

John Wiley & Sons, 15 Astor place, New York, have issued supplementary catalogues embracing new books published by them, as well as some of the standard works from their house. Their catalogue is sent free.

The Lloyd Booth Company, of Youngstown, Ohio, expect soon to erect a new machine shop, and will give special attention to rolling mill machinery. They are now working on a contract for 60 tons of such machinery to go to Birmingham, Ala.

The Wainwright Manufacturing Company are moving their general offices from Boston to Medford, Mass., where their factory is located, but will retain their location 65 and 67 Oliver street, Boston, to be used as a warehouse and salesrooms.

The iron manufacturers of the Mahoning Valley, in Ohio, claim that they are being discriminated against by the railroads in the matter of freight charges, and a committee have sent to the railroad managers a protest against it. The charges on bar iron to Chicago are especially objected to.

The Kensington Engine Works, Philadelphia, Pa., have issued part second of their illustrated catalogue of the Buckeye engine. This part of their catalogue is largely taken up with instructions relating to the use of the indicator, and data on steam engines and power plants. Engineers can find good use for this catalogue.

Weekly payments and a new time table, which gives the employes a Saturday half holiday, by the machinery shutting down at 1.30, went into effect this week in the five cotton mills operated by J. P. & J. G. Ray, and Ray, Rathbun & Co. at Woonsocket. No requests have been made for these concessions by the operatives.—*Commercial Bulletin.*

The Beckett & McDowell M'f'g Co., of Arlington, N. J., write us: We have just let contract for the building of a new brick erection shop which we intend fitting up with latest and most improved machinery for the handling of heavy work, including a Yale & Towne overhead traveling crane. Our new foundry, just completed, is now in full operation.

John Thomson, 143 Nassau street, New York, has issued a unique and tastefully printed catalogue of the printing press invented and sold exclusively by him. The press is made for him at the Colt's Armory. By card enclosed in circular Mr. Thomson invites anyone interested to call at his office and examine the working of the press, driven by an electric motor.

Chas. A. Schieren & Co., New York, write us: We have recently opened a branch house at 46 South Canal street, Chicago, where we will carry a full line of our goods, standard, short lap, electric, and leather link belting; also raw hide and tanned lace leather. Mr. Emil Gabel, formerly president of the Gabel Belting Company, of Chicago, will have charge of this branch.

Sebastian, May & Co., of Cincinnati, Ohio, have issued a new illustrated catalogue giving full descriptions and prices of the foot and power lathes, drill presses, shapers, wood-working machinery, engines and boilers made by them, and also machinists' and amateurs' supplies. They write us that it is the most complete catalogue ever issued by them, and that they will mail a copy to anyone interested upon receipt of address.

There are some interesting features about the Lima and Chicago pipe line. It will be 210 miles long and will require 64,000 barrels of oil to fill it. The largest pump ever designed is now being completed in Oil City for this line. It will weigh 110 tons and will force the oil the entire distance from Lima to Chicago. The capacity of the pump is 350 barrels an hour, or 8,400 barrels a day. When this line is completed it is thought that the demand for fuel oil will take a very large portion of the product of the great Ohio fields.—*Commercial Bulletin.*

At a meeting of business men held recently at Fort Worth, it was decided to accept the proposition of the State Alliance to locate at that city a branch of their exchange. By the terms of the proposition Fort Worth gives to the Alliance $5,000 cash, to be paid thirty days after the exchange is started, and free rent for two years, a building for the exchange to do business in, $8,000 in money to be paid, and a building to be erected by the Alliance costing not less than $15,000. The Alliance promises to erect there a grain elevator with a capacity of not less than 1,000,000 bushels.—*The Tradesman.*

Machinists' Supplies and Iron.

NEW YORK, May 10, 1888.

Iron—American Pig—We quote good to choice brands No. 1 X Foundry, $19.50 to $20 50; No. 2, $17 to $19; Grey Forge, $16 to $17, with ordinary brands as low as $15 to $15.50.

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✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Wanted—Men to sell planes, see page eleven.

Experienced mechanical draftsman wants position. Address R. G., AM. MACHINIST.

Wanted—Position by mech'l and elec'l engineer; good draftsman. Address M. E, AM. MACHINIST.

Wanted—Position as foundry foreman or assistant; at present assistant in one of the largest foundries; understands heavy and light work; would like change; temperate; best of references. Address F. E. Homier, 537 Broome street, N. Y. City.

Wanted—Foreman to take charge of machine shop who is thoroughly conversant with engine and jobbing work; state age, experience and references; first-class opportunity for proper party. Address Iron Works, care Savage & Farnum, Detroit, Mich.

✢ MISCELLANEOUS WANTS. ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Gerlach's Engineers' specialties beat the world. Send for price list. Crescent Mfg. Co., Cleveland, O.

Crescent grease cup for shafting beats them all. Sample free. Crescent Mfg. Co., Cleveland, Ohio.

Wanted—Parties having machinery specialties to build, to correspond with. Box 75, AM. MACHINIST.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Wanted—Parties having specialties to manufacture, correspond with Cedar Point Foundry and Machine Shop, Port Henry, Essex Co., N. Y.

Adamantine adhesive for making steam joints; stops leaks in boilers, stops pitting. Chas. Barnes & Co., Cincinnati, Ohio.

Wanted—Cheap testing machines for cast-iron to give contraction, deflection, and strength; also any other useful foundry tools. Jas. Evans & Co., Gaythorn, Manchester, England.

August C. Christensen, 26 Church st., N. Y. mech. and hydr. engineer. Prepares designs of waterworks pumping stations, drawings of steam pumps, pumping engines, gen. mach'ry and pat. drawings.

For Sale—In Birmingham, Ala., machine shop, equipped with best make of new mach'y; a bargain for most any manufacturer with moderate capital. Opportunity, AM. MACHINIST.

Machine shop and foundry for sale, to rent, or partner wanted. Very good location, with two railroads running by shop; poor health the cause of this offer. Address G. R. H., AM. MACHINIST.

Wanted—A 60"x60" planer to plane from 15 to 30 feet, either new or second-hand. If second-hand, must be of modern design and in first-class order. Address Fosdick & Plucker, Sixth and Culvert, Cincinnati, Ohio.

For Sale—One complete set of pulley moulding machinery to make pulleys from 6 inch to 40 inch; one 9 ton cupola; three foundry cranes; one sheet-iron core oven; crane hand ladles from 40 pounds to 7,000 pounds; complete with necessary bales and handles. Address North Star Iron Works, Minneapolis, Minn.

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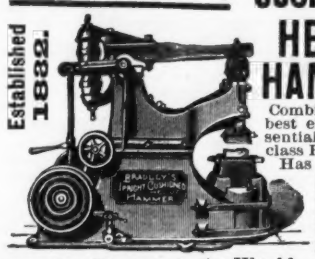

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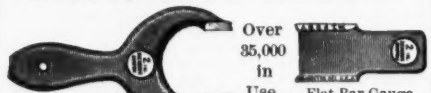

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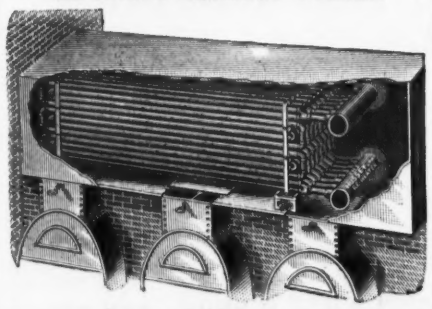

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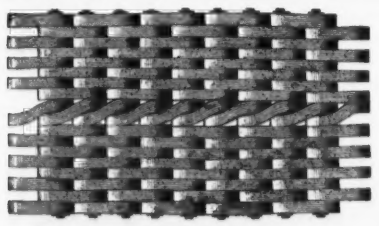

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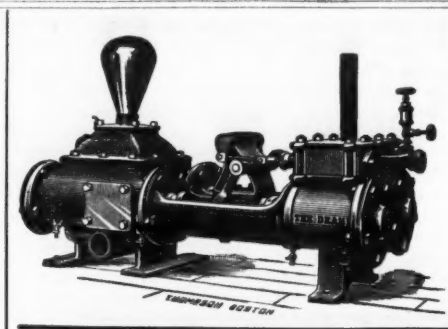

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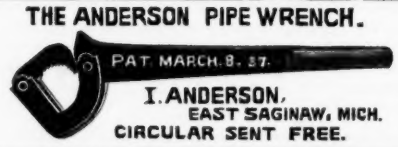

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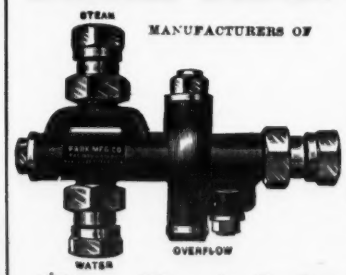

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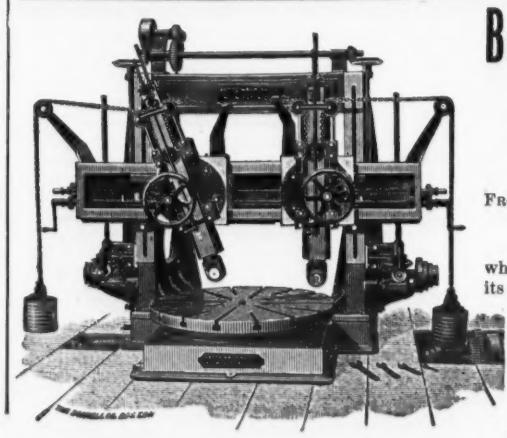

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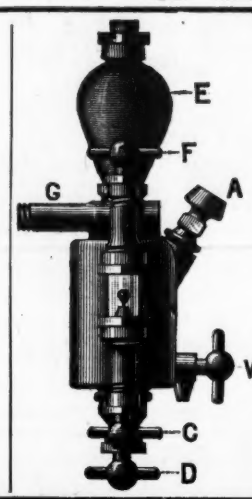

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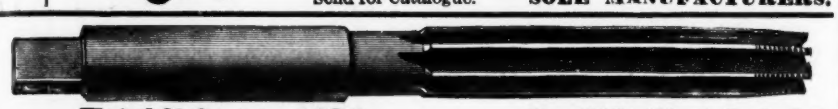

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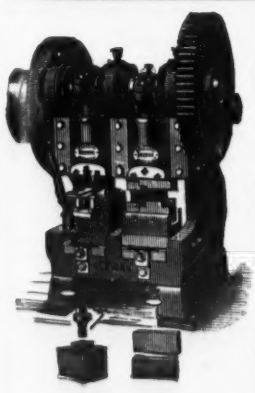

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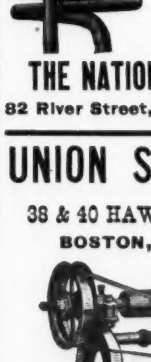

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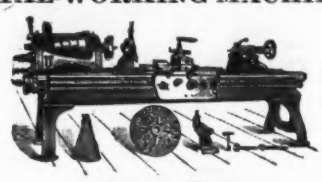

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12	2	1.20
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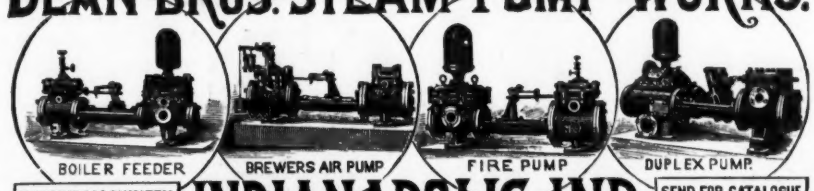

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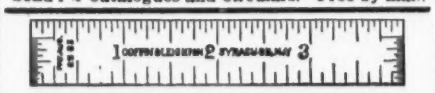

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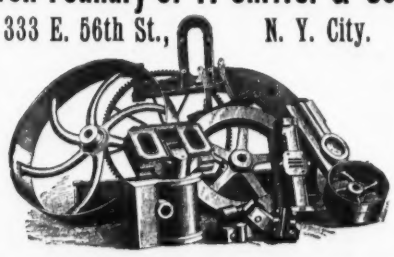

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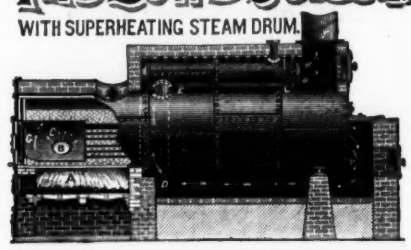

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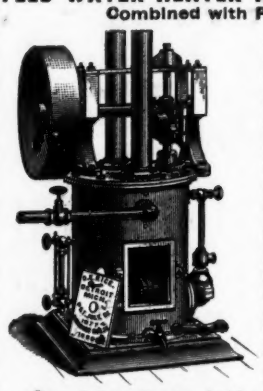

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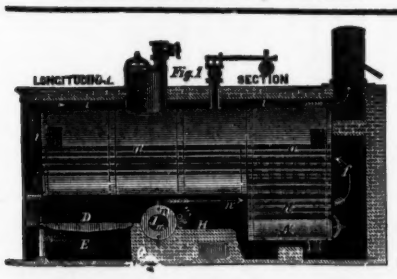

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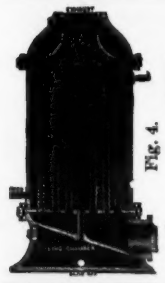

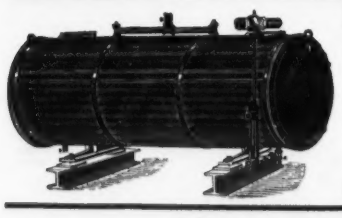

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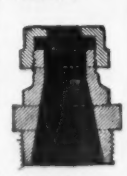

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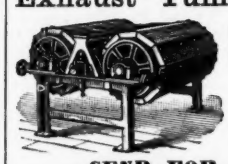

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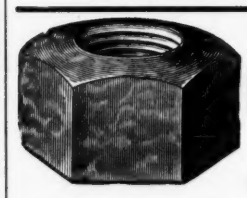

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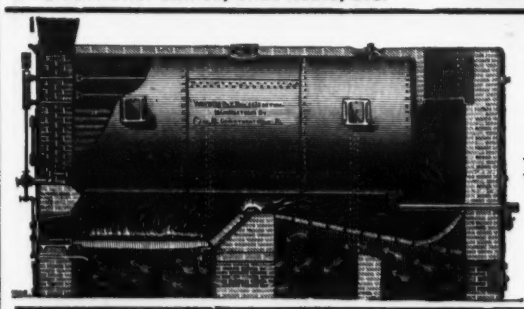

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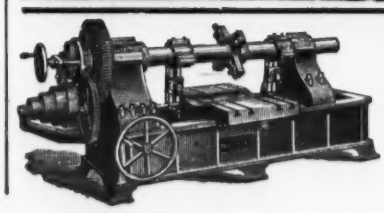

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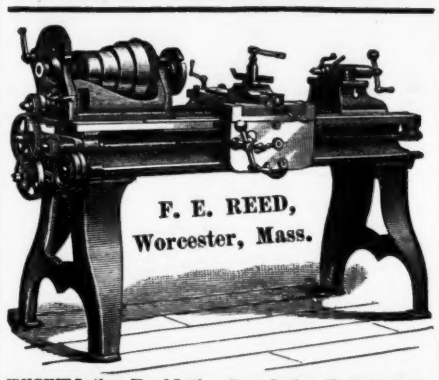

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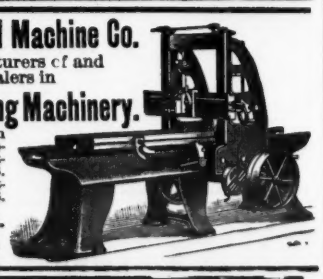

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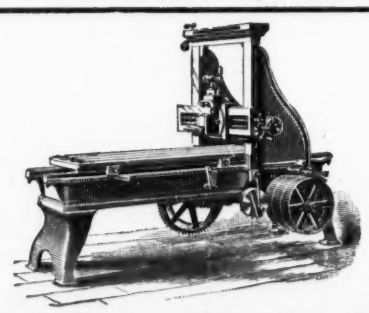

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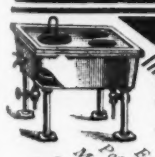

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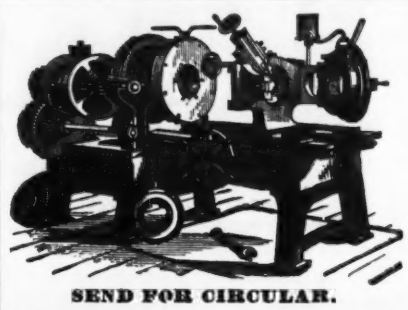

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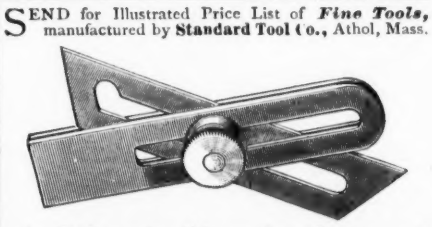

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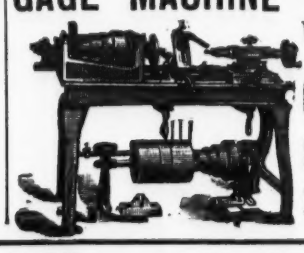

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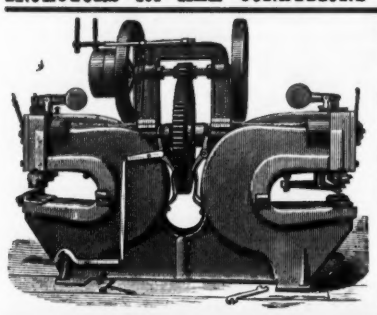

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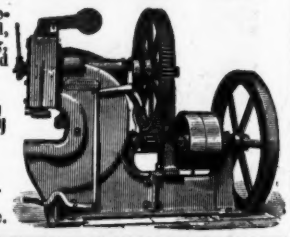

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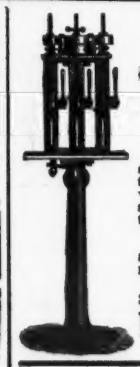

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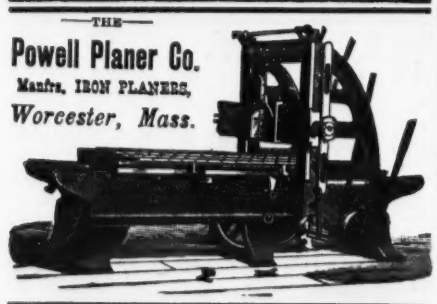

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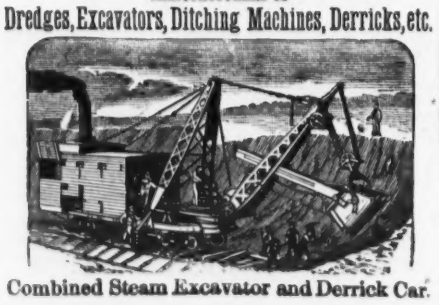

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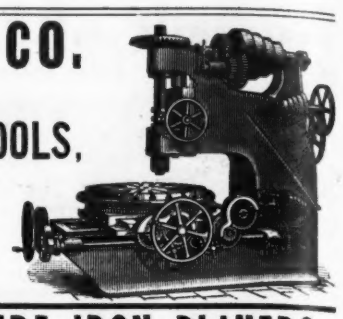

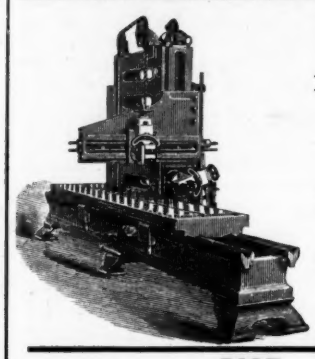

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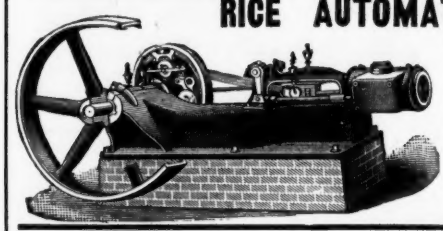

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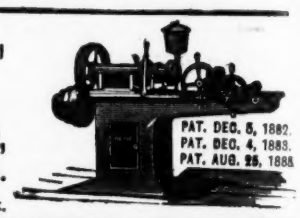

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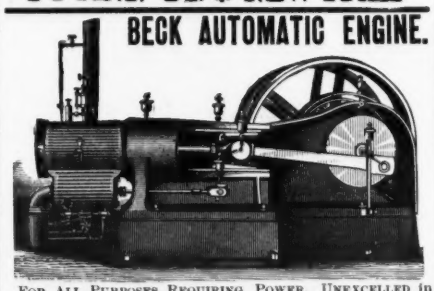

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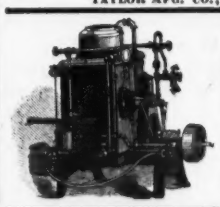

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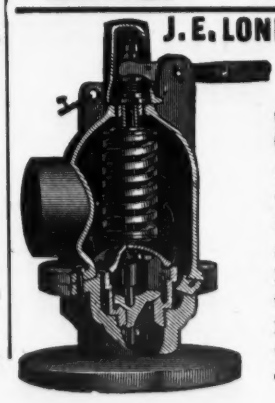

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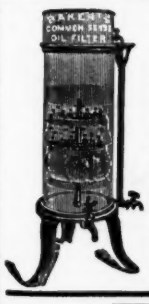

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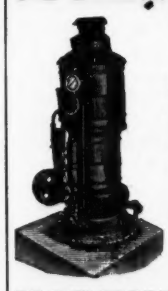

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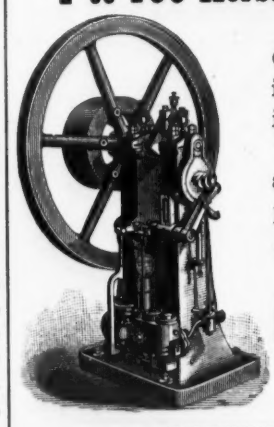

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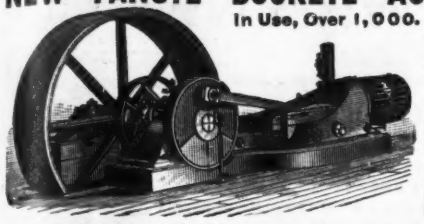

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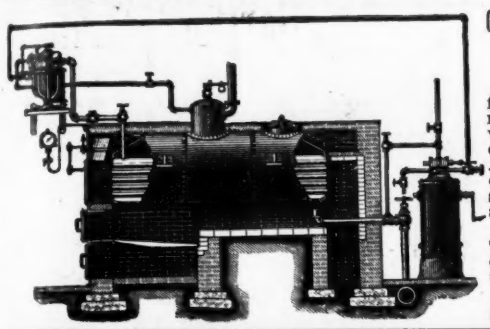

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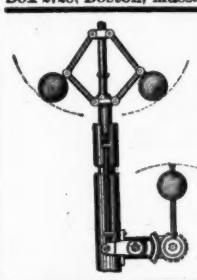

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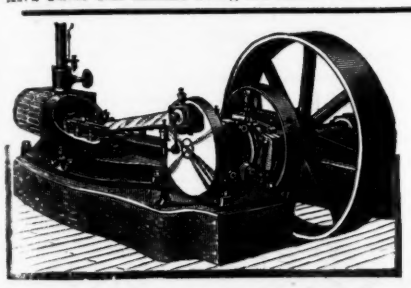

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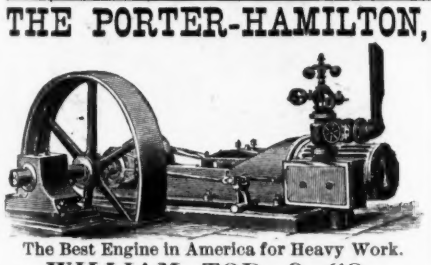

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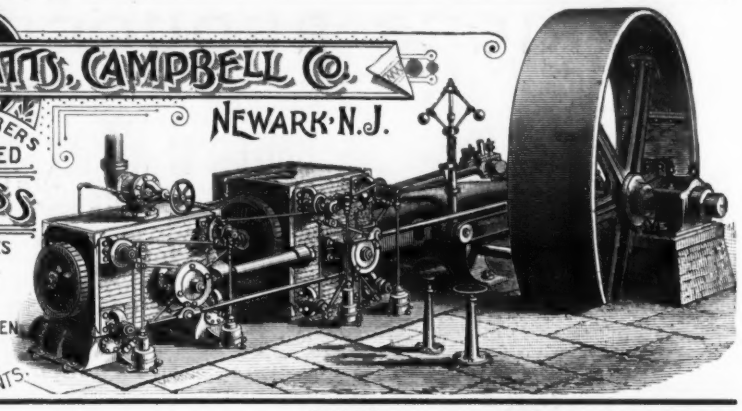

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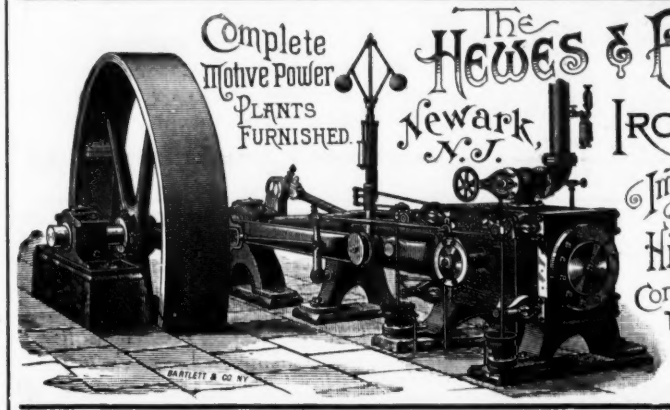

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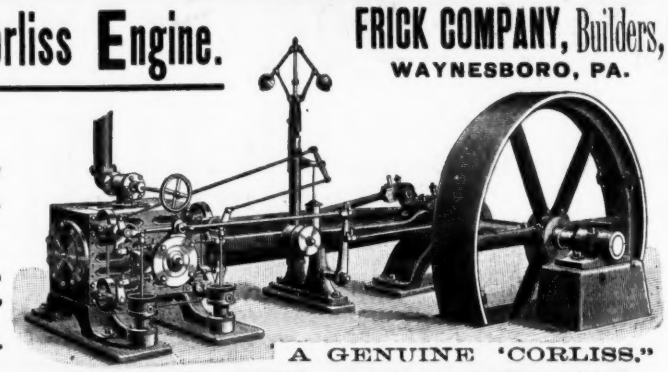

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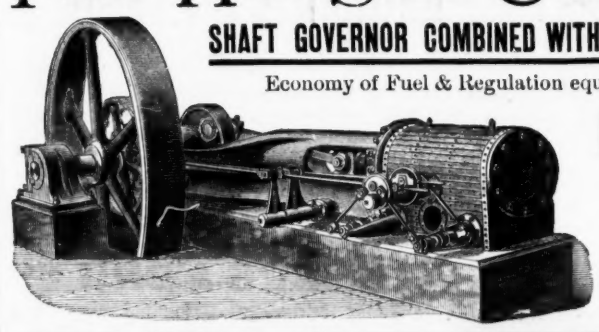

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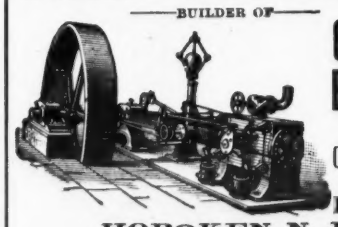

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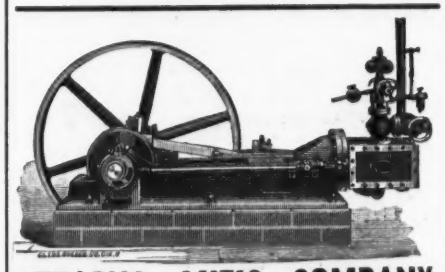

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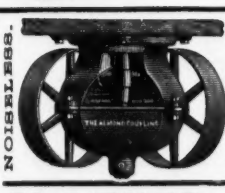

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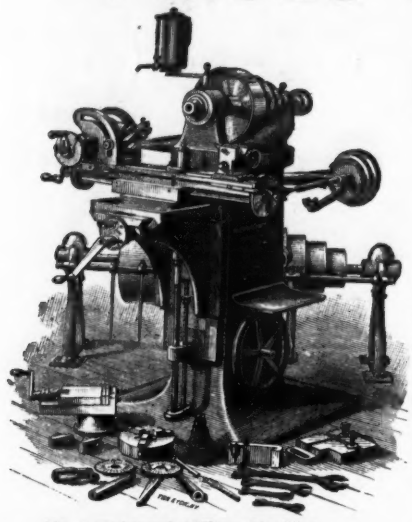

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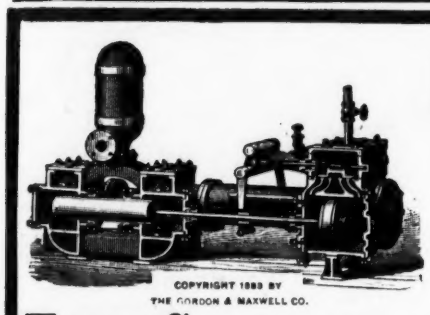

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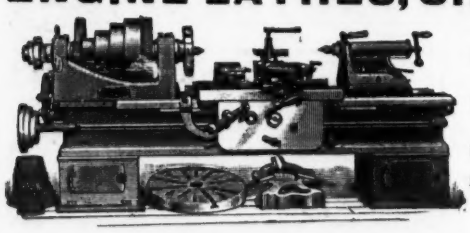

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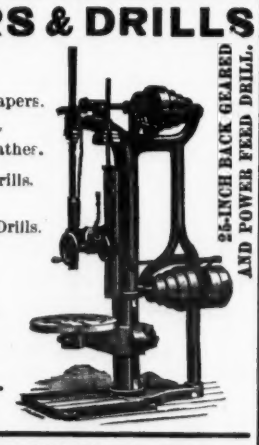

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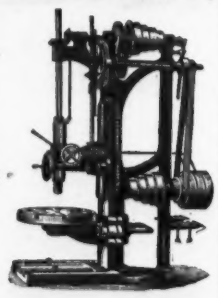

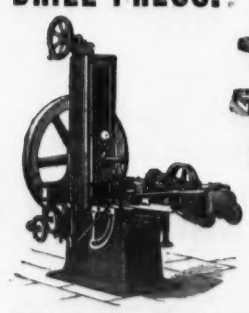

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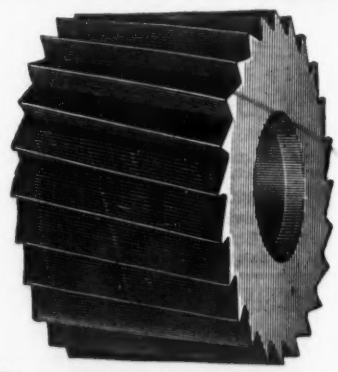

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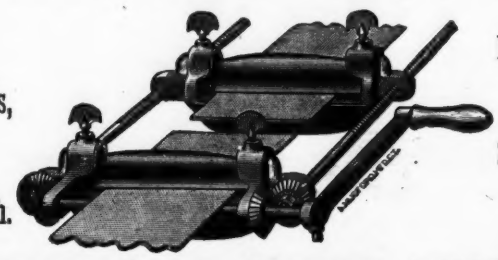

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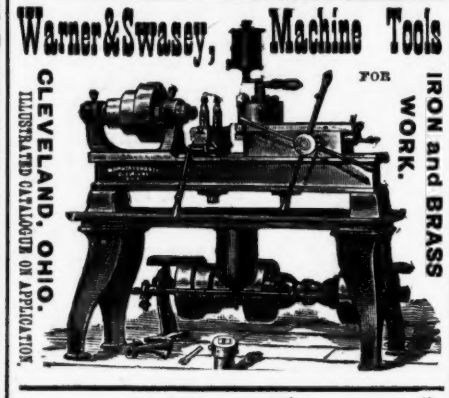

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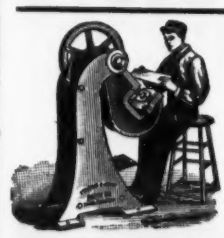

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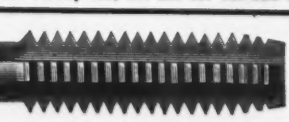

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